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CORRECTIONS.

Whole Number 35.

Applying corrections when ranging by the fork system.

P. 244. Ex. V, fourth round was omitted: it should be a — at 2000 yards.

Ex. VI, same.

P. 245. Ex. XIII, thirteenth round should be a + at 2025 yards.

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PROBLEMS IN CURVED AND INDIRECT FIRE.

The importance of indirect fire in siege operations has increased greatly during the last few years by the introduction of rifled guns, and especially of rifled howitzers and mortars; and also by the simultaneous improvement of ballistic formulas and tables whereby the art of gunnery has been reduced to an exact science. It is no longer considered practicable or desirable to construct breaching batteries as formerly on the glacis in order to batter down the scarp by direct fire, but the breach must now be effected by indirect fire from a distance of several hundred yards, as at the siege of Strassburg, during the Franco-German war of 1870-71, where the breach of the main rampart was made by indirect fire, the masonry not being visible from the demolition batteries located in the second parallel.

Curved fire is also considered by our best military writers as equaly important in operations against troops protected by the earthen parapets (breast works) inaugurated in our civil war. These were usualy thrown up in a single night and rendered the defenders comparatively safe against the direct fire of the enemy, whether of muskets or of field guns.

The admirable article by Major Tiedeman, on the necessity of employing curved fire against troops protected by field intrenchments, has been rendered accessible to our artillery officers through Lieutenant Blakely's translation printed in Vol. IX, of the *Journal of the U. S. Artillery*, and makes it unnecessary for me to deduce any argument to show the great importance of curved fire, or to cite examples of its successful use in battles and sieges.

Assuming then that curved fire will be a necessity in future field and siege operations it becomes all important to deduce formulas and prepare tables which shall enable the artillery officer to lay his guns quickly and with certainty under all circumstances that may arise. The ordinary range tables are here of but little use since the muzzle velocity is generally one of the elements to be determined, and in the great majority of cases will be less than 800 f. s. to secure the required angle of fall. The selection of the proper guns for curved firing against troops protected by earth works, or, if the ordinary field gun be employed, the method of reducing the charge so as to secure the desired muzzle velocity, are problems for the consideration of the Ordnance Department. We shall deduce formulas and compute a concise table by means of which the necessary muzzle velocity, range, angle of departure and time of flight to secure the desired results, can be easily and accurately computed.

Problems in curved fire have usually been solved by means of the tables deduced by Siacci and Lardillon from those computed in 1842 by the Prussian General Otto, after Euler's Method.* But these solutions are not so convenient as those which we shall deduce from Siacci's equations for direct fire. These primary equations, which are now well known to all Artillerists, are the following: †

$$x = C\left\{S(u) - S(V)\right\} \tag{1}$$

$$\frac{y}{x} = \tan\varphi - \frac{C}{2\cos^2\varphi}\left\{\frac{A(u) - A(V)}{S(u) - S(V)} - I(V)\right\} \tag{2}$$

$$\tan\theta = \tan\varphi - \frac{C}{2\cos^2\varphi}\left\{I(u) - I(V)\right\} \tag{3}$$

$$t = C\sec\varphi\left\{T(u) - T(V)\right\} \tag{4}$$

$$u = v\cos\theta\sec\varphi \tag{5}$$

$$C = f\frac{\delta_1 w}{\delta c \beta d^2} \tag{6}$$

In these equations

V is the velocity of the projectile as it emerges from the gun, called the muzzle velocity.

φ is the angle of projection, that is the angle which the tangent to the trajectory at the muzzle makes with the axis of x.

x, y are the rectangular coordinates of any point of the trajectory, the origin being at the muzzle of the gun and the axis of x horizontal.

v is the velocity of the projectile at the point x, y.

---

* For a full explanation of this method, with a modified form of table, see Ingalls' *Handbook of Problems in Direct Fire*, 1890, pp. 285-296.

† For a demonstration of these formulas, see *Handbook*, Appendix 1.

θ is the angle which the tangent to the trajectory at the point x, y makes with the axis of x.

t is the time of flight of the projectile from the origin to the point x, y.

u is called by Siacci the *pseudo velocity* and is employed in nearly all ballistic equations in place of the true velocity v. It is this use of the *pseudo* velocity instead of the *actual* velocity that constitutes the real essence of Siacci's method for direct fire.

C is called the *ballistic coefficient* and depends upon the weight, diameter and shape of head of projectile, its steadiness in flight and the density of the air it encounters. When properly determined it measures the ability of a projectile to overcome the resistance of the air: or, as we may say, it measures the *ballistic efficiency* of a projectile. Of the factors which make up the ballistic coefficient.

f is called the *altitude factor*, and takes into account the diminution of resistance encountered by the projectile as it rises above the earth's surface. It is greater than unity and increases with the mean altitude of the trajectory which is taken at two-thirds the maximum altitude. Its value is given by the formula*

$$\log(\log f) = \log y_0 - 4.98235 \qquad (7)$$

in which y_0 is the maximum ordinate, or the height of the summit of the trajectory, in feet. For low trajectories this factor may be taken as unity.

$\frac{\delta_1}{\delta}$ is a factor depending upon the varying density of the air near the earth's surface. The value of this factor for any observed temperature (Fahrenheit) and barometric pressure (inches of mercury) may be taken from Table III.

c is called the *coefficient of reduction*, and is unity for guns and projectiles similar to those used in making the experiments upon which the ballistic tables are based. If the qualities of the gun and projectile are such that the latter meets with a greater resistance than the experimental projectile of the same diameter the effect is the same as if the area of cross section were increased, and therefore in this case c must be greater than unity. On the other hand if the resistance a projectile encounters be less than the experimental resistance for the same cross section than for this projectile c will be less than unity. For modern guns firing projectiles having heads struck with radii of two calibers c will be taken as unity.

---

* See *Handbook*, pages 87-88 and 307.

β is Siacci's *integrating factor*, and its presence in the expression for the ballistic coefficient corrects the effect of certain erroneous assumptions which were necessarily made in deducing the primary equations, when the curvature of the trajectory is considerable. The values of these factors (which are functions of the angle of projection and range) are given in Table 2. They are taken from Siacci's paper *Nuova tavola della funzione* β.*

$S(V)$, $S(u)$, $A(V)$, $A(u)$, $I(V)$, $I(u)$, $T(V)$, $T(u)$ are certain functions of the muzzle and pseudo velocities, called, respectively, space function, altitude function, inclination function and time function. For their analytical expressions the reader is referred to any standard work on exterior ballistics.†

If we consider the entire horizontal trajectory, that is, that part of the complete trajectory lying above the level of the gun, and designate the horizontal range by X, the corresponding time of flight by T, and the angle of fall (considered positive) by ω, the primary equations become ‡

$$X = C\left\{ S(u) - S(V) \right\} \tag{8}$$

$$\sin 2\varphi = C\left\{ \frac{A(u) - A(V)}{S(u) - S(V)} - I(V) \right\} \tag{9}$$

$$\tan \omega = \frac{C}{2\cos^2 \varphi}\left\{ I(u) - \frac{A(u) - A(V)}{S(u) - S(V)} \right\} \tag{10}$$

$$T = C \sec \varphi \left\{ T(u) - T(V) \right\} \tag{11}$$

$$u = v \cos \omega \sec \varphi \tag{12}$$

With the help of Siacci's integrating factor these equations for the horizontal trajectory are practically correct for all elevations up to 45°. They can be very much simplified by the following substitutions due to Braccialini :§

---

* *Rivista d'Artiglieria e Genio* for February, 1896.

† See also *Ingalls' Handbook*, Appendix 1.

‡ For convenience of printing, the letters v and u will refer to the far end of any arc under consideration. The conditions of the problem will always indicate what arc is meant.

§ *Giornale d'Artiglieria e Genio*, part 2, 1883.

$$z = S(u) - S(V)$$

$$A = \frac{A(u) - A(V)}{S(u) - S(V)} - I(V)$$

$$B = I(u) - \frac{A(u) - A(V)}{S(u) - S(V)}$$

$$A' = A + B = I(u) - I(V)$$

$$T' = T(u) - T(V)$$

Making these substitutions in equations (8) to (11) we have, for any given muzzle velocity V for which these functions have been computed,

$$X = C z \tag{13}$$

$$\sin 2\varphi = A C \tag{14}$$

$$\tan \omega = \frac{B C}{2 \cos^2 \varphi} \tag{15}$$

$$T = C T' \sec \varphi \tag{16}$$

Equation (15) may also be written for flat trajectories, that is, when the ratio

$$\frac{\cos \varphi}{\cos \omega}$$

is approximately unity,

$$\sin 2\omega = B C \tag{17}$$

When this ratio cannot be regarded as unity we may have, by combining equations (14) and (15) and making

$$B' = \frac{B}{A}$$

the following expression for computing ω which is appliable in all cases:

$$\tan \omega = B' \tan \varphi \tag{18}$$

The values of the space. altitude, inclination and time functions, and the secondary functions derived from them, depend for any given muzzle velocity and range, upon the law of resistance.

It is generally admitted by writers on exterior ballistics that the quadratic law of resistance holds for all velocities below 800 f. s. (240 m. s.);[*] and this includes nearly all firing with mortars mountain howitzers and also the indirect fire of field and siege guns and field howitzers. For this law the ballistic functions $S(u)$, $A(u)$, $I(u)$ and $T(u)$ take the following forms:[†]

---

[*] Siacci. *Balistique*. French edition, 1892, page 84. La Llave, *Balistica Abreviada*. 1893, page 77. Zaboudski. *Exterior Ballistics* (in Russian), 1895, page 55. Bashforth, *The Bashforth Chronograph*. 1890, page 138.

[†] *Handbook*, pages 271-274.

$$S(u) = -\frac{\log_e u}{A_1} + Q_s$$

$$I(u) = \frac{g}{A_1 u^2} + Q_i$$

$$A(u) = \frac{g}{2(A_1 u)^2} - \frac{Q_i}{A_1}\log_e u + Q_a$$

$$T(u) = \frac{1}{A_1 u} + Q_t$$

and similar expressions for $S(V)$, $A(V)$, $I(V)$ and $T(V)$. Q_s, Q_i, Q_a and Q_t are constants of integration and A_1 is a constant determined by experiment. The value of A_1 which we have adopted is that deduced by Mayevski from a discussion of the Krupp firings at Meppen.* Its logarithm for English units is

$$\log A_1 = 5.6698914 - 10$$

Substituting these values in the expressions for z, A, A', B and T' the constants of integration disappear by subtraction, and we have by easy reductions

$$z = \frac{1}{A_1}\log_e\left(\frac{V}{u}\right) \tag{19}$$

$$A = \frac{g}{A_1}\left\{\frac{1}{2A_1 z}\left(\frac{1}{u^2} - \frac{1}{V^2}\right) - \frac{1}{V^2}\right\} \tag{20}$$

$$B = \frac{g}{A_1}\left\{\frac{1}{u^2} - \frac{1}{2A_1 z}\left(\frac{1}{u^2} - \frac{1}{V^2}\right)\right\} \tag{21}$$

$$A' = \frac{g}{A_1}\left(\frac{1}{u^2} - \frac{1}{V^2}\right) \tag{22}$$

$$T' = \frac{1}{A_1}\left(\frac{1}{u} - \frac{1}{V}\right) \tag{23}$$

These equations may be still further simplified by expressing them exponentially as follows: Making

$$2A_1 z = n$$

equation (19) gives

$$\frac{1}{u} = \frac{e^{\frac{1}{2}n}}{V} \therefore u = \frac{V}{e^{\frac{1}{2}n}} \tag{24}$$

and

$$\frac{1}{u^2} = \frac{e^n}{V^2}$$

Substituting these in equations (20), (21), (22) and (23) gives

$$A = \frac{g}{A_1 V^2}\left(\frac{e^n - 1}{n} - 1\right) \tag{25}$$

---

* *Revue d'Artillerie*, April, 1883. Ingalls' *Exterior Ballistics*, page 28. Zaboudski's *Exterior Ballistics* (in Russian), page 55.

$$B = \frac{g}{A_1 V^2}\left(e^{n} - \frac{e^{n} - 1}{n}\right) \tag{26}$$

$$A' = \frac{g}{A_1 V^2}\left(e^{n} - 1\right) \tag{27}$$

$$T' = \frac{1}{A_1 V}\left(e^{\frac{1}{2}n} - 1\right) \tag{28}$$

Dividing equation (26) by equation (25) gives

$$B' = \frac{1 - (1 - n)\, e^{n}}{e^{n} - n - 1} \tag{29}$$

an equation independent of the muzzle velocity V.

In addition to the secondary functions due to Braccilini we have introduced the following into Table 1:

$$A'' = \frac{B z}{A'} = z\left(\frac{1 - (1 - n)\, e^{n}}{n\,(e^{n} - 1)}\right) \tag{30}$$

$$B'' = \sqrt{200\, g\, z}\left(\frac{e^{-n} + n - 1}{n^2}\right)^{\frac{1}{2}} \tag{31}$$

$$C' = \frac{A}{z} = \frac{2g}{V^2}\left(\frac{e^{n} - 1 - n}{n^2}\right) \tag{32}$$

$$C'' = \frac{A}{2\,T'} = \frac{g}{2V}\left(\frac{e^{n} - 1 - n}{n\,(e^{\frac{1}{2}n} - 1)}\right) \tag{33}$$

$$C''' = \frac{A z}{(T')^2} = \frac{g}{2}\left(\frac{e^{n} - 1 - n}{(e^{\frac{1}{2}n} - 1)^2}\right) \tag{35}$$

The use of these secondary functions will appear later. They are connected with the elements of a trajectory by the following relations easily established for a given muzzle velocity:

$$A'' = \frac{y_0}{C \tan \varphi} \tag{35}$$

$$B'' = 10\, v\left(\frac{\sin 2\,\omega}{C}\right)^{\frac{1}{2}} \tag{36}$$

$$C' = \frac{\sin 2\,\varphi}{X} \tag{37}$$

$$C'' = \frac{\sin \varphi}{T} \tag{38}$$

$$C''' = \frac{2\, X \tan \varphi}{T^2} \tag{39}$$

Other secondary functions will be given further on, in the solution of some of the minor problems; but it was not considered worth while to tabulate them an account of the little importance in practical gunnery of the problems in which the occur, and also because these problems can be solved when desired by inspection and trial as explained in Problem Thirteen.

Table 1 is a single-entry table computed for a muzzle velocity of 800 f. s. (240 m. s.). Its argument is the quotient of the horizontal range divided by the ballistic coefficient, designated by z. Of the eleven tabulated secondary functions, A'', B', B'' and C''' are independent of V and can therefore be used for all muzzle velocities within the range of the quadratic law of resistance. The remaining seven functions depend upon V as well as z; but, as is easily seen from equations (24), (25), (26), (27), (28), (32) and (33), if these functions are tabulated for a muzzle velocity of 800 f. s. there values for any muzzle velocity less than this can be found by simply multiplying them by the ratio (or the square of the ratio) of the two muzzle velocities. By this principle not only is the labor of double interpolation (that is, interpolation with reference to both V and z), avoided, but the muzzle velocity is introduced into the equations thereby giving greater elegance and accuracy to the solutions of the problems.

By introducing V as just explained equations (12), (14), (15), (16), (17), (37) and (38) become, respectively, for *any muzzle velocity*,

$$u = v \sec \varphi \cos \omega \left(\frac{800}{V}\right) \tag{40}$$

$$\sin 2\varphi = A\,C\left(\frac{800}{V}\right)^2 \tag{41}$$

$$\tan \omega = \frac{B\,C}{2\cos^2\varphi}\left(\frac{800}{V}\right)^2 \tag{42}$$

$$T = \frac{C\,T'}{\cos\varphi}\left(\frac{800}{V}\right) \tag{43}$$

$$\sin 2\omega = B'C\left(\frac{800}{V}\right)^2 \tag{44}$$

$$C' = \frac{\sin 2\varphi}{X}\left(\frac{V}{800}\right)^2 \tag{45}$$

$$C'' = \frac{\sin\varphi}{T}\left(\frac{V}{800}\right) \tag{46}$$

If we consider these seven quantities (which may be regarded as the primary elements of a horizontal trajectory), namely, C, V, X, φ, ω, v, T, it will be found that if any three of them be known, the remaining four can be computed by means of the formulas here given, in connection with Table 1. There may therefore be thirty-five cases involving only primary elements. These are not all of equal importance and some of the cases may be of little use in gunnery. But for the sake of completeness they are all solved in the problems following, both for English and metric units, and illustrated by numerical examples.

PROBLEM ONE.

Given: C, V, X. Required: φ, ω, v, T.

Solution: Compute (see equation (13)),

$$z = \frac{X}{C}$$

and with this take u, A, $\log B'$ and T' from Table 1. Then by equations (41), (18, (40) and (43), in the order named, we have

$$\sin 2\varphi = A\,C\left(\frac{800}{V}\right)^2$$

$$\tan\omega = B' \tan\varphi$$

$$v = u\cos\varphi\sec\omega\left(\frac{V}{800}\right)$$

$$T = C\,T'\sec\varphi\left(\frac{800}{V}\right)$$

Example 1. $C = 2$, $V = 700$ f. s., $X = 1000$ yards.

We first find

$$z = \frac{X}{C} = \frac{3 \times 1000}{2} = 1500$$

and with this take from Table 1, $u = 745.9$, $A = .07902$, $\log B' = 0.02031$, $T' = 1.943$. Whence by the formulas last given, $\varphi = 5^\circ\ 57'\ 20''$, $\omega = 6^\circ\ 14'$, $v = 653$ f. s., $T = 4.465$ seconds.

For the same horizontal range and projectile, setting aside atmospheric conditions, A and C are constant in the expression

$$\sin 2\varphi = A\,C\left(\frac{800}{V}\right)^2$$

and therefore for two corresponding values of φ and V, distinguished by subscripts, we have by division

$$\frac{\sin 2\varphi}{\sin 2\varphi_1} = \left(\frac{V_1}{V}\right)^2$$

Similarly, from equation (36)

$$\frac{\sin 2\omega}{\sin 2\omega_1} = \left(\frac{v_1}{v}\right)^2$$

That is, for the same horizontal range and ballistic coefficient, the sines of twice the angles of departure are inversely as the squares of the corresponding muzzle velocities; and the sines of twice the angles of fall are inversely as the squares of the corresponding striking velocities.

From equation (18) we have, for the same conditions as before,

$$\frac{\tan \varphi}{\tan \omega} = \frac{\tan \varphi_1}{\tan \omega_1} = \text{constant}$$

That is, for the same horizontal range and ballistic coefficient, the ratios of the tangents of the angles of departure and angles of fall are equal for all trajectories described by varying the muzzle velocity, at least within the limits of direct fire.

We also have the relations

$$\frac{\tan \varphi}{\tan \varphi_1} = \frac{\tan \omega}{\tan \omega_1} = \left(\frac{T}{T_1}\right)^2$$

That is, the tangents of the angles of departure are proportional to the tangents of the corresponding angles of fall, and to the squares of the corresponding times of flight.

Example 2. In Ex. 1 suppose X and C to remain the same as there given while V becomes 750 f. s. What will be the new values of φ, ω and T?

We have

$$\sin 2\,\varphi = \left(\frac{V_1}{V}\right)^2 \sin 2\,\varphi_1 = \left(\frac{700}{750}\right)^2 \sin 11^\circ\ 54'\ 40''$$

$$\therefore\ \varphi = 5^\circ\ 10'\ 45''$$

$$\tan \omega = \frac{\tan \varphi}{\tan \varphi_1} \tan \omega_1 = \frac{\tan 5^\circ\ 10'\ 45''}{\tan 5^\circ\ 57'\ 20''} \tan 6^\circ\ 14'$$

$$\therefore\ \omega = 5^\circ\ 25'\ 20''$$

$$T = T_1 \left(\frac{\tan \varphi}{\tan \varphi_1}\right)^{\frac{1}{2}} = 5.152 \left(\frac{\tan 5^\circ\ 10'\ 45''}{\tan 5^\circ\ 57'\ 20''}\right)^{\frac{1}{2}}$$

$$\therefore\ T = 4.802 \text{ seconds.}$$

Example 3. Let X and C remain the same as before and φ be changed to 10°. What will be the muzzle velocity?

Answer.

$$V = 700 \left(\frac{\sin 11^\circ\ 54'\ 40''}{\sin 20^\circ}\right)^{\frac{1}{2}} = 543.78 \text{ f. s.}$$

It will be seen from these examples that if we have a range table for curved fire for a muzzle velocity V, we can, without recourse to any ballistic table, compute another range table having a different muzzle velocity.

Solution for metric units.

The methods developed in this paper for the solution of problems in curved fire are easily adapted to any units of length and weight. For the metric system the range and muzzle velocity are given in metres, the diameter of the projectile in centimetres and its weight in kilograms, while the coefficient of reduction, factor for atmospheric conditions and integrating factor are the same for all units. By a proper use of the factor for converting units of the metric to those of the English system the expression for C becomes

$$C = [1.15299]\, f \frac{\delta_1}{\delta} \frac{w}{c\, d^2\, \beta}$$

Also

$$z = [0.51599] \frac{X}{C}$$

$$\sin 2\varphi = [4.77420] \frac{A\, C}{V^2}$$

$$\tan \omega = B' \tan \varphi$$

$$v = [7.09691 - 10]\; V u \cos \varphi \sec \omega$$

$$T = [2.38710] \frac{C\, T'}{V \cos \varphi}$$

Example 4. $d = 24$ cm, $w = 144$ kg, $V = 200$ m. s., $X = 3250$ m. From Table 2 we find for the given range and for an angle of departure in the neighborhood of 30°, $\beta = 1.06$. Therefore, omitting from the calculation of C the altitude and atmospheric factors and making c unity, the work is as follows :—

Const. log $= 1.15299$
$\log w = 2.15836$
a. e. $\log d^2 = 7.23958$
a. c. $\log \beta = 9.97469$

$\log C = 0.52562$

Const. log $= 0.51599$
$\log X = 3.51188$
a. c. $\log C = 9.47438$

$\log z = 3.50225$
$z = 3178.7$

$\therefore\ u = 689.9$
$A = .17681$
$\log B' = 0.04300$
$T' = 4.284$

$\log V = 2.30103$
$\log u = 2.83879$
$\log \cos \varphi = 9.93344$
$\log \sec \omega = 0.07873$
a. c. log 800 $= 7.09691$

$\log v = 2.24890$
$v = 177.4$ m. s.

Const. log $= 4.77420$
$\log A = 9.24751$
$\log C = 0.52562$
a. c. $\log V^2 = 5.39794$

$\log \sin 2\varphi = 9.94527$
$2\varphi = 61^\circ\ 50'\ 10''$
$\varphi = 30^\circ\ 55'\ 5''$

$\log \tan \varphi = 9.77734$
$\log B' = 0.04300$

$\log \tan \omega = 9.82034$
$\omega = 33^\circ\ 28'$

Const. log $= 2.38710$
$\log C = 0.52562$
$\log T' = 0.63185$
a. c. $\log V = 7.69897$
$\log \sec \varphi = 0.06656$

$\log T = 1.31010$
$T = 20.42$ sec.

PROBLEM TWO.

Given: C, V, φ. Required: X, ω, v, T.

Solution: Compute (see equation (41)),

$$A = \frac{\sin 2\varphi}{C}\left(\frac{V}{800}\right)^2$$

and with this take z, u, $\log B'$, T' from Table 1. We then have (see equation (13)),

$$X = Cz$$

and ω, v, T as in Problem One.

Example 1. $C = \frac{1}{10}$, $V = 200$ f. s., $\varphi = 10°$.

Substituting these numbers in the above expression for A we find $A = .21376$, and then from Table 1 by interpolation,

$$z = 3700 + \frac{439 \times 100}{637} = 3768.9$$

$$u = 672.9 - .689 \times 3.2 = 670.7$$

$$\log B' = 0.05005 + .689 \times .00135 = 0.05098$$

$$T' = 5.049 + .689 \times .149 = 5.152$$

Therefore $X = 376.89$, $\omega = 11° 13'$, $v = 168.35$ f.s., $T = 2.093$ sec.

Example 2. The official range table* for the army magazine rifle gives $\varphi = 1° 40' 35''$ for a range of 1000 yards. Suppose we wish to practice with the sight set for this range, but with a reduced charge giving a muzzle velocity of 400 f. s. How far off should the target be placed to simulate the 1000-yard range? Take $\log C = 9.46553 - 10$ which results from making $c = 1.197$.

We find $A = .050054$ and $z = 966.2$. Therefore $X = 282.23$ ft.

With the sight set for 500 yards, 1500 yards, or 2000 yards, we find in a similar manner $X = 93.1$ feet, 571.2 feet, and 970.5 feet, respectively.

Solution for metric units.

Compute C as in Problem One and then A by the equation

$$A = [5.22580 - 10]\frac{V^2 \sin 2\varphi}{C}$$

and with this take z, u, $\log B'$, T' from Table 1. We then have

$$X = [9.48401 - 10]\, Cz$$

and ω, v, T as in Problem One.

Example 3. $d = 24$ cm, $w = 144$ kg, $V = 200$ m. s., $\varphi = 30°$.

The computations may be arranged as follows: (For the value of $\log C$ see Problem One).

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* G. O. 36, A. G. O., June 11, 1897, page 89.

$$\begin{aligned} \text{Const. log} &= 5.22580 \\ \log V^2 &= 4.60206 \\ \log \sin 2\varphi &= 9.93753 \\ \text{a. c. } \log C &= 9.47438 \\ \hline \log A &= 9.23977 \\ A &= .17369 \end{aligned}$$

Therefore by interpolation as in Problem One,

$$\begin{aligned} z &= 3127.7 \\ u &= 691.1 \\ \log B' &= 0.04231 \\ T' &= 4.210 \end{aligned}$$

$$\begin{aligned} \text{Const. log} &= 9.48401 \\ \log C &= 0.52562 \\ \log z &= 3.49523 \\ \hline \log X &= 3.50486 \\ X &= 3198 \text{ m.} \end{aligned}$$

The other answers are:

$$\begin{aligned} \omega &= 32^\circ\ 28'\ 30'' \\ v &= 177.4 \text{ m. s.} \\ T &= 19.9 \text{ seconds.} \end{aligned}$$

Example 4. $d = 21$ cm, $w = 91$ kg, $V = 204.1$ m. s., $\varphi = 45^\circ$, to compute the range. For this we have $\beta = 1.17$ and $c = 1\frac{1}{8}$. Therefore (see Problem One),

$$\log C = 0.35364.$$

Answer. $X = 3588$ m. The mean of five shots fired at Meppen with the above data was 3611 m.*

PROBLEM THREE.

Given: C, X, φ. Required: V, ω, v, T.

Solution: Compute

$$z = \frac{X}{C}$$

and with this take u, A, $\log B'$, T' from Table 1. Then

$$V = 800 \left(\frac{A\,C}{\sin 2\varphi}\right)^{\frac{1}{2}}$$

and ω, v, T as in Problem One.

Example 1. $C = 10$, $X = 100$ ft., $\varphi = 5^\circ$.

We find $z = 10$, and from Table 1, $u = 799.63$, $A = 0.000504$, $\log B' = 0.000135$, $T' = .0125$. Therefore $V = 136.3$ f. s., $\omega = 5^\circ\ 00'\ 6''$, $v = 136.3$ f. s., $T = 0.7337$ seconds.

These results are practically the same as those given by the parabolic theory, as they should be for so heavy a projectile and low velocity. The example is given to illustrate the precision of our method.

Example 2. $C = 2$, $X = 1600$ yards, $\varphi = 10^\circ$.

Answers. $V = 697.95$ f. s., $\omega = 10^\circ\ 46'\ 30''$, $v = 625.4$ f. s., $T = 7.391$ seconds.

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* Krupp's *Expériences de tir*, No. 31, January 19, 1882.

Example 3. Suppose that in gallery practice with the army magazine rifle, the distance to the target is 50 feet, and we set the sight for a range of 1000 yards. What should be the muzzle velocity in order to hit the target at the level of the muzzle?

We have $\varphi = 1^\circ\ 40'\ 35''$, $X = 50$ ft., $\log C = 9.46553$. Therefore $z = 171.18$ and $A = .00865$. Whence $V = 166.3$ f. s.

If we place the target 100 yards from the gun we shall find in the same way, that when the sight is set either for 500 yards, 1000 yards, 1500 yards, or 2000 yards, the following corresponding muzzle velocities will be required, namely: 726.0 f. s., 412.8 f. s., 285.6 f. s., and 214.3 f. s. Thus with suitable cartridges, easily provided, the 100-yard range (or any other convenient distance), can be used for the preliminary practice in sighting for all ranges. It is believed that the process indicated in this example would give to the rather tiresome sighting drill much of the emulation and interest attaching to actual target practice.

Application to Golf.

Example 4. What initial velocity must be given to a golf ball to send it 150 yards before striking the ground (supposed to be horizontal), with an angle of rise (or departure) of 10°?

The weight of a *new* Silvertown golf ball is 41.877 grammes (a little less than 1½ ounces), and its diameter is $1\frac{1}{16}$ inches. The theoretical value of c is 1.391, which in the absence of experiment, we will adopt. This gives $\log C = 8.36749 - 10$.

We now have $z = X / C = 19307$,—which is below the limit of our table. To work the example it will be necessary to compute A by equation (25), in which

$$\log \frac{g}{A_1 V^2} = 0.0312446,$$

and

$$n = [5.9709214 - 10]\, z.$$

We find $A = 1.95110$ and then $V = 291.7$ f. s.

The following calculations have been made in a similar manner:

$X = 150$ yards.			$X = 200$ yards.		
φ	V	V In vacuo	φ	V	V In vacuo
10°	291.7 f.s.	205.7 f.s.	10°	387.1 f.s.	237.5 f.s.
20	215.8	150.0	20	288.2	173.3
30	187.8	129.3	30	252.0	149.3
40	181.6	121.2	40	247.2	140.0
45	183.6	120.3	50	252.1	138.9

For these comparatively low velocities the parabolic theory (motion in *vacuo*) would give approximately correct results for artillery projectiles, but not for a golf ball, as a comparison of these values of V shows.

They also illustrate the fact, already well known, that the angle of departure giving the maximum range in air is less than 45°.

It would seem from these, and from other similar calculations, that for a long drive, where the ball strikes on ground that precludes rolling, the angle of departure should be about 42°.

Solution for metric units.

Compute z as in Problem One and with this take u, A, $\log B'$, T' from Table 1. Then

$$V = [2.38710]\left(\frac{A\,C}{\sin 2\varphi}\right)^{\frac{1}{2}}$$

and ω, v, T as in Problem One.

Example 5. $d = 24$ cm, $w = 144$ kg, $\varphi = 35°$, $X = 4000$ m.

From Table 2 we find $\beta = 1.08$, whence $\log C = 0.51751$ and $z = 3986.0$. From Table 1 we now take $u = 663.9$, $A = .22770$, $\log B' = 0.05391$, $T' = 5.477$. From these we find $V = 217.8$ m. s., $\omega = 38° \, 24'$, $v = 188.9$ m. s., $T = 24.652$ seconds,—the last three computed as in Problem One.

PROBLEM FOUR.

Given: C, φ, ω. Required: V, X, v, T.

Solution: Compute (see equation (18))

$$\log B' = \log \tan \omega - \log \tan \varphi$$

and take with this z, u, A, T' from Table 1. We then have

$$X = Cz$$

and V, v, T as in Problem Three.

Example 1. $C = \frac{1}{2}$, $\varphi = 8°$, $\omega = 10°$.

We find $\log B' = 0.09852$, $z = 7302.2$, $u = 568.54$, $A = .46692$, $T' = 10.880$; and by the formulas, $V = 736.24$ f. s., $X = 1217$ yards, $v = 526.13$ f. s. and $T = 5.967$ sec.

Solution for metric units.

Compute

$$\log B' = \log \tan \omega - \log \tan \varphi$$

and with this take z, u, A, T' from Table 1. We then have

$$X = [9.48401 - 10]\, Cz$$

and V, v, T as in Problem Three. C will be computed as in Problem One.

Example 2. $d = 27$ cm, $w = 200$ kg, $\varphi = 40°$, $\omega = 43°$.

We find from Table 2, for a range in the neighborhood of 4000 m, and for an angle of departure of 40°, that $\beta = 1.11$. Therefore by Problem One $\log C = 0.54597$. We next find $\log B' = 0.045 84$; and then from Table 1, $z = 3388.15$, $u = 682.8$, $A = .18976$, $T' = 4.590$. Then, as in Problem Three, we find $V = 200.6$ m. s., $X = 3630$ m., $v = 180.1$ m. s., $T = 25.49$ seconds.

PROBLEM FIVE.

Given: V, X, φ. Required: C, ω, v, T.

Solution: Compute (see equation (45)),

$$\log C' = 4.19382 + \log \sin 2\varphi + 2 \log V - \log X - 10$$

and with this take z, u, $\log B'$, T' from Table 1. We then have

$$\log C = \log X - \log z$$

and ω, v, T as in Problem One.

Example 1. $V = 800$ f. s., $X = 2000$ yards, $\varphi = 10°$.

We find

$$\log C' = 5.7599 - 10$$

and then from Table 1, by interpolation, $z = 3921.4$, $u = 665.94$, $\log B' = 0.05304$, $T' = 5.380$. Finally, by the formulas, $\log C = 0.18471$, $\omega = 11° 16'$, $v = 668.7$ f. s., $T = 8.36$ sec.

Solution for metric units.

Compute

$$\log C' = 4.70981 + \log \sin 2\varphi + 2 \log V - \log X - 10$$

and with this take z, u, $\log B'$, T' from Table 1. We then have

$$C = [9.36300 - 10] \frac{X}{z}$$

$$T = [3.54009] \frac{C\,T'}{V \cos \varphi}$$

and ω, v as in Problem One.

Example 2. $V = 220$ m. s., $X = 3000$ m, $\varphi = 22° 6'$.

We will give the entire work as a further illustration of how to use metric data with English tables.

$$\begin{aligned} \text{Const. } \log &= 4.70981 \\ \log \sin 2\varphi &= 9.84334 \\ 2 \log V &= 4.68185 \\ \text{a. c. } \log X &= 6.52287 \\ \hline \log C' &= 5.76087 \end{aligned}$$

$$\begin{aligned} \text{Const. } \log &= 9.36300 \\ \log X &= 3.47712 \\ \text{a. c. } \log z &= 6.36964 \\ \hline \log C &= 9.20976 - 10 \end{aligned}$$

$$\therefore z = 4200 + \frac{970}{14} = 4269.3$$

$$\begin{aligned} u &= 655.2 \\ A &= .24619 \\ \log B' &= 0.05774 \\ T' &= 5.906 \end{aligned}$$

$$\begin{aligned} \text{Const. } \log &= 3.54009 \\ \log C &= 9.20977 \\ \log T' &= 0.77129 \\ \log \sec \varphi &= 0.03314 \\ \text{a. c. } \log V &= 7.65758 \\ \hline \log T &= 1.21187 \\ T &= 16.29 \text{ sec.} \end{aligned}$$

$$\begin{aligned} \log \tan \varphi &= 9.60859 \\ \log B' &= 0.05774 \\ \hline \log \tan \omega &= 9.66633 \\ \omega &= 24^\circ\ 53' \end{aligned}$$

$$\begin{aligned} \text{Const. } \log &= 7.09691 \\ \log V &= 2.34242 \\ \log u &= 2.81637 \\ \log \cos \varphi &= 9.96686 \\ \log \sec \omega &= 0.04231 \\ \hline \log v &= 2.26487 \\ v &= 184 \text{ m. s.} \end{aligned}$$

These results are practically the same as those deduced by Siacci's table.*

Example 3. $V = 180$ m. s., $X = 2860$ m., $\varphi = 55^\circ$.

We first find

$$\log C' = 5.73697 - 10$$

and then $z = 2591.3$, $u = 708.7$, $\log B' = 0.03507$, $T' = 3.444$. Therefore

$$\log C = 9.40585 - 10 = \log\left(f\frac{\delta_1}{\delta}\,\frac{1}{c}\,\frac{w}{d^2\,\beta}\right)$$

and $\omega = 57^\circ\ 8'\ 30''$, $v = 168.6$ m. s., $T = 29.45$ sec.

PROBLEM SIX.

Given: V, φ, T. Required: C, X, ω, v.

Solution: Compute (see equation (46)),

$$\log C'' = 7.09691 + \log V + \log \sin \varphi - \log T - 10$$

and with this take z, u, A, $\log B'$ from Table 1. We then have

$$C = \frac{\sin 2\varphi}{A}\left(\frac{V}{800}\right)^2$$

and X, ω, v as in Problem Two.

Example 1. $V = 300$ f. s., $\varphi = 10^\circ$, $T = 3$ seconds

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* Siacci's *Balistique Extérieure*, 1892, page 87.

We find by the given data

$$\log C'' = 8.33658 - 10$$

and from Table 1, $z = 8409$, $u = 539.9$, $A = 0.55904$, $\log B' = 0.11334$. With these values the formulas give

$$\log C = 8.93467 - 10$$

and $X = 723.5$ ft., $\omega = 12° 54'$, $v = 204.5$ f. s.

Solution for metric units.

Compute

$$\log C'' = 7.61290 + \log V + \log \sin \varphi - \log T - 10$$

and with this take z, u, A and $\log B'$ from Table 1. We then have

$$C = [4.07281 - 10] \frac{V^2 \sin 2\varphi}{A}$$

$$X = [0.63700]\, Cz$$

and ω, v as in Problem One.

Example 2. $V = 200$ m. s., $\varphi = 30° 55' 5''$, $T = 20.42$ seconds. We find

$$\log C'' = 8.31463 - 10$$

and from Table 1, $z = 3176.3$, $u = 689.6$, $A = .17667$, $\log B' = 0.04297$. Therefore

$$\log C = 9.37298 - 10$$

and the other elements as in Ex. 4 of Problem One.

PROBLEM SEVEN.

Given: V, φ, ω. Required: C, X, v, T.

Solution: Compute (see equation (18))

$$\log B' = \log \tan \omega - \log \tan \varphi$$

and with this take z, u, A, T' from Table 1. We then have

$$\log C = 4.19382 + \log \sin 2\varphi + 2 \log V - \log A - 10$$

and X, v, T as in Problem Two.

Example 1. $V = 700$ f. s., $\varphi = 10°$, $\omega = 12°$.

We find

$$\log B' = 0.08115$$

and from Table 1, $z = 6008.2$, $u = 604.1$, $A = .36739$ and $T' = 8.672$. With these tabular values the formulas give

$$\log C = 9.85294 - 10$$

and $X = 4282.3$ ft., $v = 532.2$ f. s., $T = 7.173$ seconds.

Solution for metric units.

Compute

$$\log B' = \log \tan \omega - \log \tan \varphi$$

and with this take z, u, A, T' from Table 1. We have then

$$\log C = 4.07281 + \log \sin 2\varphi + 2 \log V - \log A - 10$$

$$X = [0.63700]\, Cz$$

and v and T as in Problem One.

Example 2. $V = 201.5$ m. s., $\varphi = 40°$, $\omega = 43°$.

We find

$$\log B' = 0.04584$$

and from Table 1, $z = 3388.15$, $u = 682{\cdot}8$, $A = .18976$ and $T' = 4.590$. Therefore

$$\log C = 9.39278 - 10$$

$$X = 3630 \text{ m.}$$

and the other elements as in Ex. 5, Problem Three.

PROBLEM EIGHT.

Given: X, φ, T. Required: C, V, ω, v.

Solution: Compute (see equation (39))

$$\log C''' = 0.30103 + \log X + \log \tan \varphi - 2 \log T$$

and with this take z, u, A, $\log B'$ from Table 1. We then have

$$\log C = \log X - \log z$$

and V, ω, v as in Problem Three.

Example 1. The six shots fired from the 8-inch pneumatic torpedo gun at Fort Lafayette, September 20, 1887, at the Schooner *Silliman* give the following data: Diameter of projectile 7.75 inches, weight of projectile including charge 137⅛ lbs., mean range 5583.5 ft., angle of departure 14° 53′ 20″, mean time of flight 10.63 seconds.*

Here $X = 5583.5$ ft., $\varphi = 14° 53' 20''$, $T = 10.63$ seconds. Therefore

$$\log C''' = 1.41955$$

and from Table 1, $z = 13925$, $u = 417$, $A = 1.13497$, $\log B' = 0.18621$. With these numbers the formulas give

$$\log C = 9.60311 - 10$$

and $V = 765.8$ f. s., $\omega = 22° 12'$, $v = 416.7$ f. s.

A standard projectile of the same diameter and weight would give

$$\log C = 0.35865$$

Whence it follows that this projectile with its spiral wings for imparting rotation, and its very unsteady flight, suffered a resistance more than 5½ times that of a service projectile.

These projectiles have been very much improved since the date of the above firing. From the report of the firing of a pneumatic torpedo gun at Shoeburyness, England, in the summer of 1890, made by B. C. Batcheller, S. B.,[*] with 8 and 10-inch sub-caliber and 15-inch full caliber dummy projectiles, is taken the following data:

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* This example will be found in the *Handbook*, page 117; in Vallier's *Balistique Extérieure*, page 93; and in La Llave's *Problemas de Balistica*, page 67.

8-inch.	10-inch.
$w = 298$ lbs.	$w = 493$ lbs.
$d = 8.27$ in.	$d = 10.25$ in.
$\varphi = 15^\circ\ 8'$	$\varphi = 15^\circ\ 10'$
$X = 2931$ yds.	$X = 2298$ yds.
$T = 12.835$ sec.	$T = 11.2$ sec.

With these data Problem Eight readily gives for the 8-inch gun $V = 822$ f. s.; and for the 10-inch gun $V = 718.6$ f. s., while the coefficients of reduction are, respectively, 2.834 and 3.403.

It will be seen that the "laborious tentative process" by which this problem was originally solved is reduced by this method to a simple, direct and easy process of as many minutes as the former required hours.

Example 2. $X = 6001$ ft., $\varphi = 18^\circ$, $T = 11.8$ sec.[†]

Answers.

$\log C''' = 1.44727$, $\log C = 9.81184 - 10$, $V = 666.7$ f. s., $\omega = 23^\circ\ 22'$ and $v = 448$ f. s.

Solution for metric units.

Compute

$$\log C''' = 0.81702 + \log X + \log \tan \varphi - 2 \log T$$

and with this take z, u, A, $\log B'$ from Table 1. We then have

$$\log C = 9.36300 + \log X - \log z - 10$$

$$V = [2.96360] \left(\frac{A\,C}{\sin 2\varphi}\right)^{\frac{1}{2}}$$

and the other elements as in Problem One.

Example 3. $X = 1701.8$ m, $\varphi = 14^\circ\ 53'\ 20''$, $T = 10.63$ sec.

We find

$$\log C''' = 1.41954$$

the same as in Ex. 1, and therefore the numbers to be taken from Table 1 are the same as there given. The above formulas give

$$\log C = 8.45012 = \log \frac{w}{c\,d^2}$$

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[*] See *Journal U. S. Artillery*, whole No. 19.

[†] The data of this example are taken from *Pro. U. S. Naval Inst.*, whole No. 69, page 30.

To find the value of the coefficient of reduction we have

$$c = \frac{w}{C d^2}$$

In our example $w = 62.2$ kg. and $d = 19.68$ cm. Whence

$$c = 5.7$$

PROBLEM NINE.

Given: X, φ, ω. Required: C, V, v, T.

Solution: Compute $\log B'$ as in Problem Four, with which take z, u, A, T' from Table 1. We then have

$$\log C = \log X - \log z$$

and V, v, T as in Problem Three.

Example 1. $X = 1000$ yds., $\varphi = 15°$, $\omega = 16°$.

We find

$$\log B' = 0.02944$$

and then $z = 2175.6$, $u = 722.6$, $A = 0.11714$, $T' = 2.863$. Whence

$$\log C = 0.13954$$

and $V = 454.7$ f. s., $v = 412.7$ f. s. and $T = 7.191$ sec.

Example 2. $X = 10$ ft., φ 10°, $\omega = 11°$.

Answers. $\log C = 7.50461 - 10$, $V = 32.236$ f.s., $v = 27.937$ f.s., $T = 0.339$ sec.

Solution for metric units.

Compute $\log B'$ as in Problem Four, with which take z, u, A, T' from Table 1. We then have $\log C, V, v$ and T as in Problem Eight.

Example 3. $X = 2860$ m, $\varphi = 55°$, $\omega = 57° 8' 30''$.

We find

$$\log B' = 0.03506$$

$A = .14140$, and the other numbers as in Ex. 2, Problem Five. Whence

$$\log C = 9.40588 = \frac{w}{c d^2 \beta}$$

PROBLEM TEN.

Given: φ, ω, T. Required: C, V, X, v.

Solution: Compute $\log B'$ as in Problem Four, with which take z, u, A, T' from Table 1. We then have by combining equations (41) and (43),

$$\log C = 9.69897 + \log A - \log \tan \varphi + 2 \log T - 2 \log T' - 10$$

and V, X, v as in Problems Two and Three.

Example 1. $\varphi = 15°$, $\omega = 16°$, $T = 12$ seconds.

The values of log B', z, u, A and T' are the same as those in Ex. 1 of Problem Nine. Whence

$$\log C = 0.58434$$

and $V = 758.8$ f. s., $X = 8354.5$ ft., $v = 688.7$ f. s.

Solution for metric units.

Compute log B' as in Problem Four, with which take z, u, A, T' from Table 1. We then have

$$\log C = 8.54598 + \log A - \log \tan \varphi + 2 \log T - 2 \log T' - 10$$

and V, X, v as in Problems Eight and Seven.

Example 2. $\varphi = 15°$, $\omega = 16°$, $T = 12$ seconds.

The tabular numbers are the same as in Ex. 1 for English units. Whence

$$\log C = 9.43135$$

and $V = 231.3$ m. s., $X = 2546$ m, $u = 209.9$ m. s.

PROBLEM ELEVEN.

Given: φ, ω, v. Required: C, V, X, T.

Solution: Compute log B' as in Problem Four, with which take z, u, A, T' from Table 1. We then have

$$V = \frac{800\, v}{u} \sec \varphi \cos \omega$$

and C, X, T as in Problems Two and Six.

Example 1. $\varphi = 5°$, $\omega = 7° 30'$, $v = 50$ f. s.

We find

$$\log B' = 0.17748$$

and by interpolation from Table 1, $z = 13257.25$, $u = 430.3$, $A = 1.05330$, $T' = 22.959$. Whence $V = 92.52$ f. s., $\log C = 7.34338 - 10$, $X = 29.23$ ft., $T = 0.4394$ sec.

Solution for metric units.

The computation of log B' and V is the same for metric as for English units. Then compute C and X as in Problem Six, and T as in Problem Five.

Example 2. $\varphi = 5°$, $\omega = 7° 30'$, $v = 15.24$ m. s.

All the tabular numbers are the same as in Ex. 1. Substituting these numbers in the formulas indicated we have

$$V = 28.2 \text{ m. s.}$$

$\log C = 6.19039 - 10$, $X = 8.9$ m., $T = 0.4394$ sec.

PROBLEM TWELVE.

Given: C, X, ω. Required: V, φ, v, T.

Solution: Compute

$$z = \frac{X}{C}$$

with which take u, A, $\log B'$, T' from Table 1. We then have

$$\tan \varphi = \frac{\tan \omega}{B'}$$

and V, v, T as in Problems One and Three.

Example 1. $C = 2$, $X = 1000$ yds., $\omega = 15°$.

We find $z = 1500$, $u = 745.9$, $A = .07902$, $\log B' = 0.02031$, and $T' = 1.943$. Therefore by the formulas, taken in order of computation, $\varphi = 14° \, 20' \, 40''$, $V = 459.0$ f. s., $v = 429.3$ f. s., $T = 6.991$ sec.

Example 2. It is desired to open a searching fire upon the enemy (protected by cover from direct fire), with shrapnel from a battery of 3.2-inch field guns, at 2000 yards. The angle of descent should be 20° to be effective. What must be the muzzle velocity and angle of elevation—also striking velocity and time of flight?

Here $X = 6000$, $\omega = 20°$, and $\log C = 0.00816$. We find $z = 5888.3$, $A = .35859$, $\log B' = 0.07954$, $T' = 8.474$ and $u = 607.4$. Therefore by the formulas, $\varphi = 16° \, 51' \, 30''$, $V = 649.01$ f. s., $v = 501.9$ f. s., $T = 11.121$ sec.

If it were considered desirable to increase the angle of fall without changing the position of the battery, it could be done only by increasing the angle of elevation and decreasing the muzzle velocity. Suppose we increase the angle of departure to 20°, what should the muzzle velocity be?

Answer.

$$V = 649.01 \left(\frac{\sin 33° \, 43'}{\sin 40°} \right)^{\frac{1}{2}} = 603.2 \text{ f. s.}$$

Solution for metric units.

Compute z and take out the tabular numbers as in Problem One. Then compute φ as for English units, and V, v, T by Problem Three.

Example 3. $d = 24$ cm, $w = 144$ kg, $c\beta = 1.1574$, $X = 2000$ m, $\varphi = 45°$.

We find

$$\log C = 0.48744$$

$z = 2135.9$, $u = 724.0$, $A = .11485$, $\log B' = 0.02890$, $T' = 2.809$. Therefore $\varphi = 43° \, 5' \, 40''$, $V = 145$ m. s., $v = 135.5$ m. s., $T = 19.87$ sec.

PROBLEM THIRTEEN.

Given: C, φ, T. Required: V, X, ω, v.

Solution: By combining equations (14), (16), (28) and (33) we obtain the equalities

$$\frac{C \tan \varphi}{T^2} = \frac{A}{2\ T'^2} = \frac{C''}{T'} = \frac{g}{4z}\left(\frac{e^n - 1 - n}{(e^{\frac{1}{2}n} - 1)^2}\right)$$

The first of these terms is a function of the given elements C, φ and T, and the last term shows that the value of this function depends on z only. In computing Table 1, therefore, it would have been easy to prepare an additional column of this function whereby z could be taken directly from the table in any particular case. But the little importance of the problem does not warrant such an extension of the table; and besides z can be found, when required, without much additional labor by "trial and error," as follows: Compute

$$\log C'' - \log T'$$

by means of the given data. Then, with the help of a table of logarithms, a near value of z as tabulated can be found by simple inspection of Table 1. A nearer value can be computed by another trial.*

Example 1. $C = 3$, $\varphi = 5°$, $T = 3$ sec.

We find

$$\log C'' - \log T' = 8.46483 - 10$$

which is satisfied when $z = 546.18$. Therefore $u = 779.9$, $A = .02792$, $\log B' = 0.00740$. Whence by Problems Two and Three $V = 555.6$ f. s., $X = 1638.5$ ft., $\omega = 5° 5'$, $v = 541.7$ f. s.

Solution for metric units.

Compute $\log C$ as in Problem One for metric units and then find

$$\log C'' - \log T'$$

as above for English units, and take z, u, A, $\log B'$ from Table 1 as already explained. Then compute V by Problem Three, X by Problem Four and ω, v by Problem One.

Example 2. $d = 24$ cm, $w = 144$ kg, $\varphi = 30°$, $T = 19.93$ sec.

From Table 2 we find $\beta = 1.06$, and then by Problem One

$$\log C = 0.52562$$

Whence by the given data,

$$\log C'' - \log T' = 7.68805 - 10$$

which is satisfied when $z = 3142.2$. The remaining elements can now be computed as already explained.

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* See *Handbook*, pages 62-64 for an illustration of the method by "trial and error."

PROBLEM FOURTEEN.

Given : C, ω, T. Required : V, X, φ, v.

Solution: By combining equations (16), (18), (26) and (28) we obtain the equalities

$$\frac{2\,C\tan\omega}{T^2} = \frac{B}{T'^2} = \frac{g}{2\,z}\left(\frac{1-(1-n)\,e^{n}}{(e^{\frac{1}{2}n}-1)^2}\right)$$

by means of which we can compute

$$\log B - 2\log T'$$

with the given data, and find z from Table 1 by inspection and trial as explained in Problem Thirteen. Then take out u, A, $\log B'$ and compute

$$\tan\varphi = \frac{\tan\omega}{B'}$$

and the other elements as in Problems Two and Three.

Example 1. $C = 2$, $\omega = 20°$, $T = 10$ seconds.

We find

$$\log B - 2\log T' = 8.16313 - 10$$

and by trial that it is satisfied when $z = 2289$. Therefore $u = 718.8$, $A = .12369$, $\log B' = 0.03098$. Whence $X = 4578$ ft., $\varphi = 18° \, 43'$, $V = 510.4$ f. s., $v = 462.2$ f. s.

Solution for metric units.

Proceed as in Problem Thirteen.

PROBLEM FIFTEEN.

Given : C, ω, v. Required : V, X, φ, T.

Solution : Compute (see equations (12), (15) and (31))

$$B'' = 10\,v\left(\frac{\sin 2\,\omega}{C}\right)^{\frac{1}{2}}$$

with which take z, u, $\log B'$, T' from Table 1 and then compute the required elements as in Problems One, Two, Eleven and Fourteen.

Example 1. $C = 1$, $\omega = 15°$, $v = 200$ f. s.

We get from the given data

$$B'' = 1414.2$$

from which we find $z = 635.2$, $u = 776.6$, $\log B' = 0.00861$, $T' = 0.806$. Whence $V = 206$ f. s., $X = 635.2$ ft., $\varphi = 14° \, 43'$ and $T = 3.236$ seconds.

Example 2. "An escarp had to be breached at the siege of

Strasburg by a gun, equivalent to an 8-inch howitzer of 70 cwt., on the same level. From information received from a spy, the ditch was known to be about 50 feet wide; in consequence of which the necessary angle of descent was calculated to be 14°. The howitzer was using common shell and delay action fuze, and the Engineers required that the striking velocity was not to fall short of 600 f. s.

Find the least requisite distance of the howitzer from the escarp, the necessary muzzle velocity and angle of departure." *

Here $w = 180$, $d = 8$, $c = \frac{10}{9}$, $\log C = 0.40333$, $v = 600$ f. s., $\omega = 14°$.

From the given data we get

$$B'' = 2584$$

and then from Table 1, $z = 2224$, $u = 721.0$, $\log B' = 0.03010$, $T' = 2.930$. Therefore $V = 663$ f. s., $X = 1876$ yds., $\varphi = 13° 6'$, $T = 9.18$ sec.

Example 3. Suppose (see Ex. 2) that it was found necessary to increase the striking velocity to 700 f. s.

We now have $B'' = 3014.7$, $z = 3108.6$, $u = 691.7$, $\log B' = 0.04206$. Therefore $V = 805$ f. s., $X = 2623$ yds., and $\varphi = 12° 45'$.

The muzzle velocity would therefore have to be increased 142 f. s. and the guns retired 747 yards. This supposes the ground to be level. The case where the guns and the escarp to be breached are at different levels will be considered later.

Example 4. The guns are to be mounted in the second parallel which is 800 yards from the escarp. If the striking velocity is to be 600 f. s. what will be the muzzle velocity, angle of projection and striking angle?

Here $\log C = 0.40333$, $X = 2400$ ft., $v = 600$ f. s. to find V, φ and ω. Solved by Problem Twenty-one. *Answers.*

$V = 627$ f. s.
$\varphi = 5° 50'$
$\omega = 6° 1'$

Example 5. If ω is 14° what will v be, the range remaining the same as in Ex. 4? Also compute V and φ.

Here we have given C, X and ω. Solved by Problem Twelve. *Answers.*

$V = 417$ f. s.
$\varphi = 13° 36' 30''$
$v = 399.6$ f. s.

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* *Text Book of Gunnery.* London, 1897. Page 269.

Solution for metric units.

Compute C as in Problem One, and then B'' by the equation

$$B=[1.51599]\,v\left(\frac{\sin 2\omega}{C}\right)^{\frac{1}{2}}$$

with which take z, u, $\log B'$, T' from Table 1. Then compute φ by Problem Twelve, V by Problem Eleven, X by Problem Two and T by Problem One.

Example 6. $d = 27$ cm, $w = 200$ kg, $\omega = 7°$, $v = 200$ m. s.

We first find

$$\log C = 0.59130$$

and then

$$B'' = 1633.8$$

by means of which we get from the table, $z = 853$, $u = 768.8$, $\log B' = 0.01155$, $T' = 1.088$. Therefore $\varphi = 6° \; 49'$, $V = 208.1$ m. s., $X = 1015$ m, $T = 5.01$ sec.

PROBLEM SIXTEEN.

Given: X, T, ω. Required: C, V, φ, v.

Solution: By combining equations (13), (26), (28), (42) and (43) we obtain

$$\frac{2X\tan\omega}{T^2} = \frac{Bz}{T'^2} = \frac{g}{2}\left(\frac{1-(1-n)\,e^{n}}{(e^{\frac{1}{2}n}-1)^2}\right)$$

by means of which, with the given data, we can compute

$$\log B + \log z - 2\log T'$$

and then find z from Table 1 by inspection and trial. Next take out u, A, $\log B'$ and compute the required elements as in Problems Three, Five and Fourteen.

Example 1. $X = 3000$ ft., $\omega = 16°$, $T = 7$ seconds.

From the given data we find

$$\log B + \log z - 2\log T' = 1.54545$$

which by trial is found to be satisfied when

$$z = 5531.3$$

Whence, $\log C = 9.73429$, $V = 503.2$ f. s., $\varphi = 13° \; 34' \; 20''$, $v = 391.0$ f. s.

Solution for metric units.

Compute

$$\frac{Bz}{T'^2} = [0.81702]\frac{X\tan\omega}{T^2}$$

and proceed as with English units.

PROBLEM SEVENTEEN.

Given: X, ω, v. Required: C, V, φ, T.

Solution: By combining equations (13), (24), (26), (40) and (42), eliminating all the elements except those given by the problem, we have

$$\frac{v^2 \sin 2\omega}{X} = \frac{B u^2}{z} = 2g\left(\frac{1 - (1 - n)e^n}{n^2 e^n}\right)$$

by means of which, using the giving data, we can compute

$$\log B + 2 \log u - \log z$$

and find z from Table 1 by inspection and trial. Then proceed as in previous problems.

Example. $X = 6000$ ft., $\omega = 15^\circ$, $v = 600$ f. s.

We find

$$\log B + 2 \log u - \log z = 1.47712$$

which is satisfied when

$$z = 2270$$

Therefore $\log C = 0.42212$, $\varphi = 14^\circ\ 1'$, $V = 664.2$ f. s., $T = 9.823$ sec.

Solution for metric units.

Compute

$$\frac{B u^2}{z} = [0.51599]\frac{v^2 \sin 2\omega}{X}$$

and proceed as already explained.

PROBLEM EIGHTEEN.

Given: ω, v, T. Required: C, V, X, φ.

Solution: The combination of equations (24), (26), (28), (40), (42) and (43) gives

$$\frac{2v \sin \omega}{T} = \frac{B u}{T'} = g\left(\frac{1 - (1 - n)e^n}{n e^{\frac{1}{2}n}(e^{\frac{1}{2}} - 1)}\right)$$

by means of which, and the given data, compute

$$\log B + \log u - \log T'$$

and proceed as in Problem Thirteen.

Example. $\omega = 20^\circ$, $v = 100$ f. s., $T = 2.2$ sec.

We find

$$\log B + \log u - \log T' = 1.49266$$

which is satisfied when

$$z = 4788$$

Therefore $\log C = 8.68293 - 10$, $V = 123.18$ f. s., $X = 231$ ft., and $\varphi = 17^\circ\ 24'\ 35''$.

Solution for metric units.

Compute

$$\frac{B\,u}{T'} = [0.81702]\,\frac{v \sin \omega}{T}$$

and proceed as already explained.

PROBLEM NINETEEN.

Given: C, V, ω. Required: X, φ, v, T.

Solution: For a first approximation assume

$$\cos \varphi = \cos \omega$$

and compute (Eq. (42))

$$B = \frac{\sin 2\,\omega}{C} \left(\frac{V}{800}\right)^2$$

with which take z, u, A, T' from Table 1, and then compute X, φ, v, T as in Problems One and Two. Repeat if necessary making

$$B = \frac{2 \cos^2 \varphi \tan \omega}{C} \left(\frac{V}{800}\right)^2$$

which is its true value.

Example. $C = 3$, $V = 650$, $\omega = 5°$.

We find by computation

$$B = .0382$$

and then from Table 1, $z = 727.3$, $u = 773.3$, $A = .03739$, $T' = 0.925$. Whence $X = 2181.9$ ft., $\varphi = 4° \; 53'$, $v = 628.3$ f. s., $T = 3.428$ sec. These results are practically correct, but when φ and ω differ considerably from each other it will be necessary to repeat where great accuracy is desired.

Solution for metric units.

Compute log C as in Problem One, and B by the approximate equation

$$B = [5.22580 - 10]\,\frac{V^2 \sin 2\,\omega}{C}$$

Repeat as explained above.

PROBLEM TWENTY.

Given: C, V, v. Required: X, φ, ω, T.

Solution: Assuming for a first approximation

$$\cos \varphi = \cos \omega$$

compute

$$u = v \left(\frac{800}{V}\right)$$

with which take z, A, $\log B'$, T' from Table 1, and then compute the required elements as in Problems One and Two. If necessary u can be re-computed by the complete formula

$$u = v \sec \varphi \cos \omega \left(\frac{800}{V}\right)$$

Example. $C = 1$, $V = 800$ f. s., $v = 732$ f. s.

We find by the approximate formula

$$u = 732$$

which corresponds in Table 1 to $z = 1900$, $A = .10139$, $\log B' = 0.02572$, $T' = 2.484$. Whence $X = 1900$ ft., $\varphi = 2° 54' 30''$, $\omega = 3° 5'$ and $T = 2.487$ sec. These results need no correction.

Solution for metric units.

Same as for English units.

PROBLEM TWENTY-ONE.

Given: C, X, v. Required: V, φ, ω, T.

Solution: Compute

$$z = \frac{X}{C}$$

with which take u, A, $\log B'$, T' from Table 1. Then assuming for a first approximation

$$\cos \varphi = \cos \omega$$

compute

$$V = \frac{800\, v}{u}$$

and then φ, ω, T as in Problems One and Two. Repeat when necessary by making

$$V = \frac{800\, v}{u} \sec \varphi \cos \omega$$

which is its true value.

Example 1. $C = 1$, $X = 3000$ ft., $v = 600$ f. s.

Answers. $V = 690$ f. s., $\varphi = 6° 26'$, $\omega = 7° 3'$, $T = 4.66$ sec.

Solution for metric units.

Compute z as in Problem One and then V as above for English units.

Example 2. $d = 24$ cm, $w = 144$ kg, $X = 3250$ m, $v = 177.4$ m.

We have already found (see Ex. 4, Problem One)

$$u = 689.9, \quad A = .17681, \quad \log B' = 0.04300, \quad T' = 4.284.$$

The successive approximations in this case are the following:

V	φ	ω
205.7 m.	28° 14′	30° 40′
200.8	30 30	33 2
200.1	30 51	33 24
200	30 55	33 28

The last set of values are correct.

PROBLEM TWENTY-TWO.

Given: V, X, v. Required: C, φ, ω, T.

Solution: Proceed as in Problem Twenty, computing the required elements as in Problems One, Two and Five.

Example. $V = 800$ f. s., $X = 4000$ ft., $v = 692$ f. s.

Answers. $\log C = 0.11070$, $\varphi = 6° 25'$, $\omega = 7° 3'$, $T = 5.41$ sec.

Solution for metric units.

Proceed as for English units.

PROBLEM TWENTY-THREE.

Given: V, φ, v. Required: C, X, ω, T.

Solution: Proceed as in Problem Twenty, computing the required elements as in Problems Two and Six.

Example. $V = 200$ f. s., $\varphi = 2°$, $v = 116.25$ f. s.

Answers. $\log C = 7.70198 - 10$, $X = 58.4$ ft., $\omega = 2° 52'$, $T = 0.39$ sec.

Solution for metric units.

Proceed as for English units.

PROBLEM TWENTY-FOUR.

Given: V, v, T. Required: C, X, φ, ω.

Solution: Proceed as in Problem Twenty, computing φ by the equation

$$\sin \varphi = \frac{A}{2} \frac{T}{T'} \left(\frac{800}{V} \right)^2$$

obtained by combining equations (41) and (43); and the other elements as in Problems Two and Six. Repeat with cos φ and cos ω if necessary.

Example. $V = 800$ f. s., $v = 732$ f. s., $T = 2$ sec.

Answers. $\log C = 9.90554 - 10$, $X = 1528.6$ ft., $\varphi = 2° 20'$, $\omega = 2° 29'$.

Solution for metric units.

Proceed as for English units computing sin φ by the equation

$$\sin \varphi = [4.47317] \frac{A}{V^2} \frac{T}{T'}$$

PROBLEM TWENTY-FIVE.

Given: V, ω, v. Required: C, X, φ, T.

Solution: Proceed as in Problem Twenty, computing the required elements as in Problems Two, Six and Fourteen.

Example. $V = 800$ f. s., $\omega = 20^\circ$, $v = 692$ f. s.

Answers. $\log C = 0.50160$, $X = 10593$ ft., $\varphi = 18^\circ\ 10'$, $T = 15.08$ sec.

Solution for metric units.

Same as for English units.

PROBLEM TWENTY-SIX.

Given: C, φ, v. Required: V, X, ω, T.

Solution: Combining equations (40) and (41), eliminating V, we have

$$A\, u^2 = \frac{2\, v^2 \tan \varphi \cos^2 \omega}{C} = 2\, g\, z \left(\frac{e^n - 1 - n}{n^2\, e^n} \right)$$

which, if we assume for a first approximation,

$$\cos \varphi = \cos \omega$$

becomes

$$A\, u^2 = \frac{v^2 \sin 2\, \varphi}{C}$$

By means of this last equation find z from Table 1, by inspection and trial, and then compute the required elements by methods already given, repeating if necessary by using the complete expression for $A\, u^2$.

Example. $C = 5$, $\varphi = 2^\circ$, $v = 500$ f. s.

Answers. $V = 502.3$ f. s., $X = 545.7$ ft., $\omega = 2^\circ\ 00'\ 24''$, $T = 0.685$ sec.

Solution for metric units.

The ballistic coefficient will be computed as in Problem One, and then $A\, u^2$ by the equation

$$A\, u^2 = [1.03198]\, \frac{v^2 \sin 2\, \varphi}{C}$$

Then proceed as explained for English units.

PROBLEM TWENTY-SEVEN.

Given: V, ω, T. Required: C, X, φ, v.

Solution: Combining equations (42) and (43), eliminating C, we obtain

$$\frac{B}{T'} = \frac{2\ V \cos\varphi \tan\omega}{800\ T} = \frac{g}{V}\left(\frac{1 - (1 - n)\,e^{n}}{e^{n} - 1}\right)$$

or, assuming

$$\cos\varphi = \cos\omega$$

we have

$$\frac{B}{T'} = \frac{2\ V \sin\omega}{800\ T}$$

with which proceed as already explained.

Example. $V = 800$ f. s., $\omega = 5°$, $T = 4$ sec.

We find

$$\log B - \log T' = 8.63927 - 10$$

which is satisfied when

$$z = 2046$$

Answers. $\log C = 0.17208$, $X = 3041$ ft., $\varphi = 4° 41'$, $v = 727$ f.s. These require no correction.

Solution for metric units.

Compute first

$$\frac{B}{T'} = [7.91393 - 10]\,\frac{V \sin\omega}{T}$$

and then proceed as already explained.

PROBLEM TWENTY-EIGHT.

Given: X, φ, v. Required: C, V, ω, T.

Solution: Combining equations (13), (40) and (41), eliminating C and V, we obtain

$$\frac{A\ u^2}{z} = \frac{2\ v^2 \tan\varphi \cos^2\omega}{X} = 2\ g\left(\frac{e^{n} - 1 - n}{n^2\ e^{n}}\right)$$

or, assuming

$$\cos\varphi = \cos\omega$$

we have

$$\frac{A\ u^2}{z} = \frac{v^2 \sin 2\varphi}{X}$$

to be employed as a first approximation.

Example. $X = 1600$ ft., $\varphi = 5°$, $v = 540$ f. s.

Answers. $\log C = 0.80031$, $V = 546.4$ f. s., $\omega = 5° 2' 20''$, $T = 3.73$ sec.

Solution for metric units.

Compute first

$$\frac{A\ u^2}{z} = [0.51599]\,\frac{v^2 \sin 2\varphi}{X}$$

and proceed as for English units.

PROBLEM TWENTY-NINE.

Given: φ, v, T. Required: C, V, X, ω.

Solution: Combining equations (40), (41) and (43), eliminating C and V, we obtain

$$\frac{Au}{T'} = \frac{2\,v \tan\varphi \cos\omega}{T} = g\left(\frac{e^{n} - 1 - n}{n\,e^{\frac{1}{2}n}\,(e^{\frac{1}{2}n} - 1)}\right)$$

which by the usual assumption becomes

$$\frac{Au}{T'} = \frac{2\,v \sin\varphi}{T}$$

for a first approximation.

Example. $\varphi = 5^\circ$, $v = 550$ f. s., $T = 4$ sec.

Answers. $\log C = 9.52575 - 10$, $V = 791.9$ f. s., $X = 2615$ ft., $\omega = 6^\circ\ 21'\ 30''$.

Solution for metric units.

First compute

$$\frac{Au}{T'} = [0.81612]\frac{v \sin\varphi}{T}$$

and proceed as already explained in previous problems.

PROBLEM THIRTY.

Given: V, X, ω. Required: C, φ, v, T.

Solution: Combining equations (13) and (42), eliminating C, we have

$$\frac{B}{z} = \frac{2\cos^2\varphi \tan\omega}{X}\left(\frac{V}{800}\right)^2 = \frac{2g}{V^2}\left(\frac{1 - (1 - n)\,e^{n}}{n^2}\right)$$

which, if we assume that

$$\cos\varphi = \cos\omega$$

becomes

$$\frac{B}{z} = \frac{\sin 2\,\omega}{X}\left(\frac{V}{800}\right)^2$$

for a first approximation.

Example. $V = 550$ f. s., $X = 1600$ f. s., $\omega = 5^\circ$.

We find by the approximate formula

$$\log B - \log z = 5.71009 - 10$$

which is satisfied when

$$z = 296.5$$

Therefore by Problems One and Five, $\log C = 0.73219$, $\varphi = 4^\circ\ 57'$, $v = 542$ f. s., $T = 2.95$ sec. These results need no correction.

Solution for metric units.

We have

$$\frac{B}{z} = [5.01084 - 10]\,\frac{V^2 \cos^2\varphi \tan\omega}{X}$$

or, approximately,

$$\frac{B}{z} = [4.70981 - 10]\,\frac{V^2 \sin 2\omega}{X}$$

PROBLEM THIRTY-ONE.

Given: C, V, T. Required: X, φ, ω, v.

Solution: We have from equation (43)

$$T' = \frac{T\cos\varphi}{C}\left(\frac{V}{800}\right)$$

For a first approximation assume

$$\cos\varphi = 1$$

and compute

$$T' = \frac{T}{C}\left(\frac{V}{800}\right)$$

with which take A from Table 1. Then compute φ by equation (41), and a new and more correct value of T' by the complete formula, with which take A again from the table. Repeat these operations until the change in T' is unimportant. The required elements can then be computed as in Problems One and Two. When φ is small but one correction of T' will be necessary.

Example. $C = 3$, $V = 800$ f. s., $T = 10$ sec.

We first find $T' = 3\frac{1}{3}$ and $\varphi = 12^\circ\, 7'$. Next $T' = 3.259$ and $\varphi = 11^\circ\, 49'$. Finally $T' = 3.263$, and no further correction is necessary.

Answers. $X = 7380$ ft., $\varphi = 11^\circ\, 49'$, $\omega = 12^\circ\, 44'$, $v = 715$ f. s.

Solution for metric units.

Compute C as in Problem One, and then T' by the formulas

$$T' = [7.61290 - 10]\,\frac{TV}{C}$$

and

$$T' = [7.61290 - 10\,\frac{TV\cos\varphi}{C}$$

PROBLEM THIRTY-TWO.

Given: C, X, T. Required: V, φ, ω, v.

Solution: Compute (see equation (13))

$$z = \frac{X}{C}$$

and with this take u, A, log B', T' from Table 1. We then have from equation (43)

$$V = \frac{800\ C\ T' \cos\varphi}{T}$$

and the required elements as in Problem One. In computing V it will be necessary to assume for a first approximation

$$\cos\varphi = 1$$

which is accurate enough when φ is less than 5°. For greater values of φ we must repeat the operation as many times as is necessary.

Example. $C = 3$, $X = 2000$ yds., $T = 10$ sec.

We find $z = 2000$, $u = 728.6$, $A = 0.10707$, log $B' = 0.02707$, $T' = 2.621$. Omitting cos φ we find $V = 629.04$ and $\varphi = 15° 39'$. Introducing cos φ and repeating the operation four times we finally obtain $V = 600.3$ f. s. and $\varphi = 17° 23'$ which are their true values. The other elements are $\omega = 18° 26'$, $v = 550.0$ f. s.

Solution for metric units.

Compute z as in Problem One with which take u, A, log B' and T' from Table 1. We then have

$$V = [2.38710] \frac{C\ T' \cos\varphi}{T}$$

PROBLEM THIRTY-THREE.

Given: V, X, T. Required: C, φ, ω, v.

Solution: Compute (see equations (13) and (43)),

$$\frac{T'}{z} = \frac{T\ V \cos\varphi}{800\ X} = \frac{2}{V}\left(\frac{e^{\frac{1}{2}n} - 1}{n}\right)$$

assuming for a first approximation cos $\varphi = 1$. Find z from the table by inspection and trial and take out u, A, log B'. The required elements can then be computed as in Problems One and Five. Repeat the operation with cos φ as many times as may be necessary.

Example. $V = 550$ f. s., $X = 1600$ ft., $T = 3$ sec

Answers. log $C = 0.15104$, $\varphi = 5° 4' 35''$, $\omega = 5° 15' 30''$, $v = 522$ f. s.

Solution for metric units.

Same as for English units.

PROBLEM THIRTY-FOUR.

Given: C, v, T. Required: V, X, φ, ω.

Solution: Compute (see equations (40) and (43)),

$$T' u = \frac{T v \cos \omega}{C} = 2 z \left(\frac{e^{\frac{1}{2} n} - 1}{n e^{\frac{1}{2} n}} \right)$$

assuming for a first approximation

$$\cos \varphi = \cos \omega = 1$$

Find z from the table by inspection and trial and take out u, A, $\log B'$. We then have approximately

$$V = \frac{800 v}{u}$$

$$X = C z$$

$$\sin 2 \varphi = A C \left(\frac{800}{V} \right)^2$$

$$\tan \omega = B' \tan \varphi$$

Repeat as often as may be necessary supplying the factors $\cos \varphi$ and $\cos \omega$ in the expression for V, and $\cos \omega$ in the expression for $T' u$.

Example. $\log C = 9.52575 - 10$, $v = 550$ f. s., $T = 4$ sec.

Answers. $V = 792$ f. s., $X = 2615$ ft.. $\varphi = 5°$, $\omega = 6° 21' 30''$.

Solution for metric units.

Compute C as in Problem One and $T' u$ by the equation

$$T' u = [0.51599] \frac{T v \cos \omega}{C}$$

and proceed as in English units.

PROBLEM THIRTY-FIVE.

Given: X, v, T. Required: C, V, φ, ω.

Solution: Compute (see equations (13), (40) and (43)),

$$\frac{T' u}{z} = \frac{T v \cos \omega}{X} = 2 \left(\frac{e^{\frac{1}{2} n} - 1}{n e^{\frac{1}{2} n}} \right)$$

and proceed as in Problem 34.

Example. $X = 1200$ yds., $v = 525$ f. s., $T = 6$ sec.

We have, by two approximations, $\log C = 9.73863$, $V = 710$ f.s., $\varphi = 8° 16'$, $\omega = 10° 6'$.

Solution for metric units.

Same as for English units.

We have now provided for all the cases that can arise employing only what we have called primary elements, in connection with horizontal trajectories, that is, when the target and gun are at the same level. But this would rarely be the case in field service except on our western plains or on the Atlantic and Gulf seaboard. In campaigns in rolling and especially in mountainous regions the guns and objects to be fired at will generally be on different levels, and it therefore becomes necessary to establish convenient formulas for these conditions, which we now proceed to do.

From equation (1) we have

$$S(u) = \frac{X}{C} + S(V)$$

and therefore the *pseudo* velocity at any point of the trajectory is independent of the height of this point above (or below) the level of the gun, but depends only, for the same projectile, on the muzzle velocity and the horizontal distance from the muzzle of the gun, which is the origin of coordinates. That is u is independent of y and depends only upon V and x. Therefore, making

$$\frac{A(u) - A(V)}{S(u) - S(V)} - I(V) = a$$

$$I(u) - \frac{A(u) - A(V)}{S(u) - S(V)} = b$$

$$I(u) - I(V) = a + b = a'$$

equations (2) and (3) become for any velocity V less than 800 f. s.,

$$\frac{y}{x} = \tan\varphi - \frac{aC}{2\cos^2\varphi}\left(\frac{800}{V}\right)^2 \qquad (47)$$

$$\tan\theta = \tan\varphi - \frac{a'C}{2\cos^2\varphi}\left(\frac{800}{V}\right)^2 \qquad (48)$$

But we have (equation (41)), for a velocity V,

$$\sin 2\varphi = AC\left(\frac{800}{V}\right)^2.$$

Whence by substitution and reduction,

$$\frac{y}{x} = \frac{\tan\varphi}{A}\left(A - a\right) \qquad (49)$$

$$\tan\theta = \frac{\tan\varphi}{A}\left(A - a'\right) \qquad (50)$$

In these equations a and a' are functions of x/C, where x is the abscissa of any point of the trajectory; while A is a function of X/C, X being the entire horizontal range. That is, for the same trajectory A is constant while a and a' vary with x. It is evident that A and a are to be taken from the same column in Table 1 but with different arguments; and a' from the "A′" column. These equations, it will be observed, are independent of the muzzle velocity.

We may express y/x in another form which is sometimes useful as follows:—As has been said already a refers to the point of the trajectory x, y; but as the pseudo velocity is independent of the height of this point and depends only on x, or the horizontal distance from the muzzle of the gun, we may consider x as the range of another horizontal trajectory whose angle of departure may be designated by φ_x, and we may have

$$a = \frac{\sin 2\varphi_x}{C}\left(\frac{V}{800}\right)^2$$

as well as

$$A = \frac{\sin 2\varphi}{C}\left(\frac{V}{800}\right)^2$$

Substituting these in equation (49) we have by a slight reduction

$$\frac{y}{x} = \frac{1}{2\cos^2\varphi}\left\{\sin 2\varphi - \sin 2\varphi_x\right\} \qquad (51)$$

This equation can also be changed to the form

$$\frac{y}{x} = \tan(\varphi - \varphi_x)\left\{1 - \frac{\sin^2\varphi_x}{\cos^2\varphi}\right\} \qquad (52)$$

If, in equation (49), we make

$$\frac{y}{x} = \tan \varepsilon$$

ε will be the angular distance of the point x, y above (or below) the level of the gun. Substituting we have

$$\tan \varepsilon = \frac{\tan\varphi}{A}\left(A - a\right) \qquad (53)$$

Subtracting this last from equation (50) gives

$$\tan \varepsilon - \tan \theta = \frac{\tan\varphi}{A}\left(a' - a\right)$$

But by defination, if ε and θ refer to the same point of the trajectory,

$$a' - a = b$$

Therefore we have this relation between the three angles φ, θ and ε, namely,

$$\tan \varepsilon - \tan \theta = \frac{b}{A}\tan\varphi$$

where b is to be taken from the "B" column of Table 1 with the argument x/C. Substituting for A its value from equation (41) and for b its value from equation (42). namely,

$$\tan \omega_x = \frac{b\,C}{2 \cos^2 \varphi_x}\left(\frac{800}{V}\right)^2$$

we have finally the simple relation

$$\tan \varepsilon - \tan \theta = \tan \omega_x \left(\frac{\cos \varphi_x}{\cos \varphi}\right)^2 \qquad (54)$$

At the summit of a trajectory θ is zero, and for this point equation (50) reduces to the identity

$$a' = A$$

Substituting this in equation (49) and distinguishing symbols referring to the summit by zero subscripts we have

$$\frac{y_0}{x_0} = \frac{a'_0 - a_0}{a'_0} \tan \varphi = \frac{b_0}{a'_0} \tan \varphi$$

But we have

$$x_0 = C z_0$$

and therefore

$$y_0 = C \frac{b_0\, z_0}{a'_0} \tan \varphi$$

Making

$$\frac{b_0\, z_0}{a'_0} = A''$$

we have finally

$$y_0 = A''\, C \tan \varphi$$

which is equation (35) and is independent of the muzzle velocity.

We will now apply equations (47)–(54) to the solution of some important problems.

PROBLEM THIRTY-SIX.

Given: Any three of the primary elements of a horizontal trajectory. Required: The coordinates of the summit (x_0, y_0), and the summit velocity.

Solution: If C, V and φ are not known they must first be computed from the given data by means of the proper Problems. Then either take A from Table 1 or compute it by the formula

$$A = \frac{\sin 2\varphi}{C}\left(\frac{V}{800}\right)^2$$

Then, since at the summit $A' = A$, find the value of A in the "A′" column of Table 1 and take out the corresponding values of z, u, A'', designating the first two, since they refer to the summit, by z_0, u_0. We then have

$$x_0 = Cz_0$$
$$y_0 = A'' C \tan \varphi$$
$$v_0 = \frac{V}{800} u_0 \cos \varphi$$

Example 1. Compute x_0, y_0, v_0 for the trajectory of Ex. 2, Problem Twelve.

Here log $C = 0.00816$, $V = 649.01$ f. s., $\varphi = 16° 51' 30''$ and $A = .35859$. Making

$$A' = 0.35859$$

we find by interpolation from Table 1,

$$z_0 = 3000 + \frac{100 \times 104.9}{133} = 3079$$
$$u_0 = 695.3 - .79 \times 3.3 = 692.7$$
$$A'' = 1570 + .79 \times 55 = 1613$$

Therefore by the formulas, $x_0 = 3137$ ft., $y_0 = 498$ ft., $v_0 = 537.8$ f. s.

Example 2. Compute the summit elements for the trajectory of Ex. 2, Problem Fifteen.

Here log $C = 0.40333$, $V = 663.1$ f. s., $\varphi = 13° 6'$ and $A = A' = .11980$. Therefore from Table 1

$$z_0 = 1100 + \frac{100 \times 34}{112} = 1130,$$
$$u_0 = 759.9 - .3 \times 3.5 = 758.8,$$
$$A'' = 560 + .3 \times 51 = 575,$$

and by the formulas $x_0 = 2860$ ft., $y_0 = 338.7$ ft., $v_0 = 612.6$ f. s.

Solution for metric units.

Proceed as explained for English units, computing A (if not taken from Table 1) by the equation

$$A = [5.22580 - 10] \frac{V^2 \sin 2\varphi}{C}$$

which is also the summit value of A'. With this value of A' take z_0, u_0 and A'' from Table 1, and then compute x_0, y_0, v_0 by the formulas

$$x_0 = [9.48401 - 10]\, Cz_0$$
$$y_0 = [9.48401 - 10]\, A'' C \tan \varphi$$
$$v_0 = [7.09691 - 10]\, V u_0 \cos \varphi$$

Example 3. Compute the summit elements for the trajectory of Ex. 3, Problem Two.

Here log $C = 0.52562$, $V = 200$ m. s., $\varphi = 30°$, $A = .17369 = A'$. Therefore

$$z_0 = 1600 + \frac{100 \times 1.9}{117} = 1601.6$$

$$u_0 = 742.4 - \frac{1.9 \times 3.5}{117} = 742.3,$$

$$A'' = 820 + \frac{1.9 \times 5^2}{117} = 820.84,$$

and by the formulas $x_0 = 1637$ m, $y_0 = 484.5$ m, $v_0 = 160.7$ m. s.

Example 4. Compute the summit elements for the trajectory of Ex. 2, Problem Five.

Here log $C = 0.36276$, $V = 200$ m. s., $\varphi = 22° \; 6'$ and $A = .24619 = A'$. Therefore

$$z_0 = 2200 + \frac{5.9 \times 100}{123} = 2204.8,$$

$$u_0 = 721.8 - \frac{5.9 \times 3.4}{123} = 721.6,$$

$$A'' = 1138 + \frac{5.9 \times 53}{123} = 1140.5,$$

and by the formulas $x_0 = 1552$ m, $y_0 = 325.4$ m, $v_0 = 183.9$ m. s.

The maximum ordinate is of no special interest in itself but is useful for correcting the ballistic coefficient when it is considered necessary to take into account the mean altitude of the projectile.* The logarithm of the atmospheric factor f which is to be added to the uncorrected log C is found (for English units) by the equation

$$\log (\log f) = \log y_0 + 5.01765 - 10$$

and for metric units

$$\log (\log f) = \log y_0 + 5.53364 - 10$$

It is assumed in these formulas that the mean altitude of the projectile during its flight is two-thirds of the uncorrected maximum ordinate.

Example 5. Compute the range (corrected for the altitude) for the 7 inch siege mortar, muzzle velocity 690 f. s., angle of departure 45°.

Here $d = 7$ inches, $w = 125$ lbs., $c = 1$, $\beta = 1.17$, $V = 690$ f. s., $\varphi = 45°$.

The work may be arranged as follows :

---

* See *Handbook*, Problem XIII.

$$\begin{aligned}
\log w &= 2.09691\\
\log(\beta\, d^2) &= 1.75839\\
\hline
\log(w/\beta\, d^2) &= 0.33852\\
\hline
\log V &= 2.83885\\
\log 800 &= 2.90309\\
\hline
& 9.93576\\
& 2\\
\hline
& 9.87152\\
\log(w/\beta\, d^2) &= 0.33852\\
\hline
\log A' &= 9.53300\\
A' &= 0.34120\\
\hline
\therefore A'' &= 1515 + \frac{63 \times 55}{132} = 1541\\
\hline
\log A'' &= 3.18780\\
\log(w/\beta\, d^2) &= 0.33852\\
\text{Const. log} &= 5.01765\\
\hline
\log 0.03499 &= 8.54397\\
\log(w/\beta d^2) &= 0.33852\\
\hline
\log C &= 0.37351
\end{aligned}$$

$$\begin{aligned}
2(\log V/800) &= 9.87152\\
\log C &= 0.37351\\
\hline
\log A &= 9.49801\\
A &= 0.31478\\
\hline
\therefore z &= 5200 + \frac{54300}{702} = 5277.3\\
\hline
\log z &= 3.72241\\
\log C &= 0.37351\\
\hline
\log X &= 4.09592\\
X &= 12472 \text{ ft.} = 4157 \text{ yds.}
\end{aligned}$$

Example 6. Compute the range of Ex. 4, page 13, corrected for altitude.

Answer. $\log C = 0.38687$, $X = 3628$ m.

PROBLEM THIRTY-SEVEN.

Given: y_0, C, φ. Required: The remaining elements of the trajectory.

Solution: Compute (see equation (35))

$$A'' = \frac{y_0}{C \tan \varphi}$$

with which take A' from the table and find its value in the A column. With this latter take out z, u, $\log B'$, T', and compute the elements as in Problems Three and Four.

Example 1. $C = 1$, $\varphi = 10°$, $y_0 = 50$ ft.

We find $A'' = 283.56$, $A' = A = .05796$, $z = 1113.7$. Therefore $X = 1113.7$ ft., $V = 329.3$ f. s.

As the muzzle velocity is quite small in this example, it will be interesting to see how the above range compares with that given by the parabolic theory. By this theory we have

$$X = 4\, y_0 \cot \varphi$$

Giving to y_0 and φ the values in the above example we find $X = 1134.3$ ft.

Solution for metric units.

Compute C as in Problem One and then A'' by the formula

$$A'' = [0.51599] \frac{y_0}{C \tan \varphi}$$

with which proceed as for English units, and in Problems Three and Four.

Example 2. $d = 24$ cm, $w = 144$ kg, $y_0 = 10$ m, $\varphi = 10°$.

The following is the work in full. For log C see Problem One.

Const. log $= 0.51599$
log $y_0 = 1.00000$
a. c. log $C = 9.47438$
log cot $\varphi = 0.75368$

log $A'' = 1.74405$
$A'' = 554.7$

$$\therefore A' = A = .1053 + \frac{46.7 \times 111}{52} = .10629$$

$$\therefore z = 1900 + \frac{49000}{568} = 1986.3$$

Const. log $= 9.48401$
log $C = 0.52562$
log $z = 3.29805$

log $X = 3.30768$
$X = 2031$ m.

log $A = 9.02649$
log $C = 0.52562$
log cosec $2\varphi = 0.46595$
2) 0.01806
0.00903
Const. log $= 2.38710$

log $V = 2.39613$
$V = 249$ m.s.

PROBLEM THIRTY-EIGHT.

Given: The elements of a trajectory. Required: The equation of the trajectory and the value of y for any given value of x.

Solution: Solved by equation (49), namely,

$$y = \frac{\tan \varphi}{A} (A - a)\, x$$

In this equation, it must be remembered, A refers to the complete horizontal trajectory and is either taken from Table 1 with the argument

$$z = \frac{X}{C}$$

or computed by the formula

$$A = \frac{\sin 2\varphi}{C} \left(\frac{V}{800}\right)^2$$

according to the given data. The quantity a varies with the abscissa x and is taken from the same column as A with the argument

$$z = \frac{x}{C}$$

Approximate Solution for flat trajectories.

In equation (52) when φ and φ_x are small, the term

$$\frac{\sin^2 \varphi_x}{\cos^2 \varphi}$$

may be omitted in comparison with unity and the equation reduces to the very simple expression

$$y = x \tan (\varphi - \varphi_x) \qquad (55)$$

If we have a table of fire for the gun in question φ_x can be taken directly from it with the range x. If not φ_x must be computed by the formula

$$\sin 2 \varphi_x = a\, C \left(\frac{800}{V}\right)^2$$

Example 1. $C = 2$, $X = 4000$ ft., $\varphi = 10°$, $x = 3000$ ft.

With the two arguments $z = 2000$ and $z = 1500$ we find from Table 1, $A = .10707$ and $a = .07902$. The equation of this trajectory is therefore

$$y = [0.21665]\ (.10707 - a)\, x$$

Making $a = .07902$ and $x = 3000$ gives $y = 138.58$ ft. We also have by Problem Three $V = 633$ f. s.

Working this example by equation (55) we find

$$\varphi_x = 7° \ 18' \ 40'' \text{ and } y = 140.9 \text{ ft.}$$

The difference between these two values of y of course disappears if we restore the term

$$\left(\frac{\sin \varphi_x}{\cos \varphi}\right)^2$$

to equation (52). The labor is about the same by both methods so that there is nothing gained by employing equation (55) unless we have a table of fire from which to take the angle φ_x.

Example 2. $C = 1$, $V = 700$ f. s., $\varphi = 20°$, $x = 3000$ ft.

In this example a must be taken from Table 1 with the argument $z = 3000$, while A must be computed by the formula

$$A = \frac{\sin 2 \varphi}{C} \left(\frac{V}{800}\right)^2$$

We find $A = .49213$ and $a = .16590$. Whence the equation of the trajectory is

$$y = [9.86899 - 10]\ (.49213 - a)\, x$$

When $x = 3000$ ft., $y = 723.8$ ft.

Example 3. $C = 1$, $V = 700$ f. s., $X = 3000$ ft., $x = 100$ ft.

In this example take A and a from Table 1 with the arguments $z = 3000$ and $z = 100$. Then compute φ by Problem One and y as already illustrated.

Answers.

$$\varphi = 6^\circ\ 15'\ 25''$$

$$y = [9.82012 - 10]\ (.16590 - a)\ x$$

When $x = 100$ ft., $y = 10.63$ ft.

By equation (55) $y = 10.57$ ft.

Example 4. Suppose that in Ex. 2 of Problem Fifteen, there was a ridge between the position selected for the gun and the escarp to be breached, whose crest was 80 ft. above the level of the gun and 100 yards from the escarp. Would the shot clear the crest?

Here from Problem Fifteen and the new data, $X = 1875$ yards, $\varphi = 13^\circ\ 6'$, $z = 2221.7$, $A = 0.11979$, $x = 5325$ ft. and $\log C = 0.40333$, to find y. The new value of z from which to get a from the table is $5325/C = 2103.7$, from which $a = .11300$. We next find $\log (\tan \varphi/A)$ to be 0.29295. The general expression for y for this trajectory is therefore

$$y = [0.29295] \left\{ 0.11979 - a \right\} x$$

and supplying the values of a and x for this particular case, we find

$$y = 70.98 \text{ ft.}$$

The projectile would then strike the ridge 9 ft. below its crest. To carry the projectile over the ridge and not diminish the striking velocity the gun must be placed further from the escarp, assuming the ground to be level. Suppose the gun to be placed 300 yards further from the escarp, would the projectile then clear the ridge? In this case we have $X = 2175$ yds. $= 6525$ ft., $\log C = 0.40313$ and $v = 600$ f.s. to find the other elements of the trajectory by Problem Twenty-one, and y as above. In computing V by Problem Twenty-one we will employ the values of φ and ω already given or found, since although they will both be increased by the new data, still the *ratio* of their cosines will be sensibly unaltered. We find $z = 2577.8$. $u = 709.1$, $A = .14061$, $\log B' = 0.03488$. Whence $V = 674.25$ f. s., $\varphi = 15^\circ\ 2'\ 5''$, $\omega = 16^\circ\ 14'$. To compute y we have $x = 6225$ ft., $x/C = 2459.3$ and $a = .13363$. by means of which we find $y = 83.00$ ft. The projectile would then clear the ridge by three feet. We may now determine the distance of the gun from the escarp so that the projectile would just graze the ridge as follows: For a range of 5625 ft. the trajectory passes 9.02 ft. below the crest of the ridge; and for a range of 6525 ft. the trajectory is too high by 3 ft. We therefore have the proportion

$$12:900::3:225$$

whence the required range is 6525 — 225 = 6300 ft. With this value of X we find $z = 2488.9$, and from Table 1, $u = 712.2$, $A = .13537$, $\log B' = 0.03368$. Whence $V = 670$ f. s., $\varphi = 14° 37' 15''$, $\omega = 15° 44' 30''$. The value of y computed for these last data is 80.24 ft. The problem is therefore completely solved.

Solution for metric units.

Compute C and z as in Problem One and then y as for English units.

Example 5. Compute the ordinate for the trajectory of Ex. 4, Problem One, when $x = 400$ m.

Here $\log C = 0.52562$, $A = .17681$, $\varphi = 30° 55'$. The equation to the trajectory is easily found to be

$$y = [0.52983]\ (0.17681 - a)\ x$$

We have first to find from the A column of Table 1 the value of a for the given value of x, with the argument z computed by the equation

$$z = [0.51599]\ \frac{x}{C}$$

We find $z = 391.23$, $a = 0.01990$ and $y = 212.4$ m.

PROBLEM THIRTY-NINE.

Given: The elements of a horizontal trajectory. Required: The value of x for any given value of y.

Solution: Substituting Cz for x in equation (49) and transposing, we have

$$(A - a)\ z = \frac{Ay}{C} \cot \varphi$$

The second member of this equation consists of known quantities while in the first member a and z are both unknown. They can easily be found however from Table 1 by inspection and trial. We then have

$$x = Cz$$

Example 1. $C = 1$, $V = 800$ f. s., $\varphi = 5°$, $y = 50$ ft.

By Problem Two we find $A = .17365$, and therefore the trial equation becomes

$$\log\ (.17367 - a)\ z = 1.99669$$

This equation is satisfied when $z = 728.7$ and also 2451; and since the ballistic coefficient in this example is unity these are the two values of x required, in feet.

The corresponding abscissas *in vacuo* are 722.4 and 2732.4 feet.

Solution for metric units.

The trial equation for metric units is

$$(A - a) z = [0.51599] \frac{A y}{C \tan \varphi}$$

Having determined z from Table 1 by trial compute the required abscissa by the equation

$$x = [9.48401 - 10]\, C z$$

Example 2. With the data of Ex. 4, Problem One, compute the longer abscissa corresponding to $y = 1\frac{1}{2}$ m.

Employing numbers already found in the example referred to, the operations are as follows:

$$\begin{aligned} \log A &= 9.24751 \\ \log y &= 0.17609 \\ \text{a. c. } \log C &= 9.47438 \\ \log \cot \varphi &= 0.22266 \\ \text{Const. } \log &= 0.51599 \\ \hline \log 0.43314 &= 9.63663 \end{aligned}$$

The trial equation is therefore

$$(.17681 - a)\, z = 0.43314$$

which is found to be satisfied when

$$\begin{aligned} z &= 5176.4 \\ \log z &= 3.50194 \\ \log C &= 0.52562 \\ \text{Const. } \log &= 9.48401 \\ \hline \log x &= 3.51157 \\ x &= 3247.7 \text{ m.} \end{aligned}$$

The only practical application of this problem relates to that part of the trajectory near the striking point, in determining the breadth of the danger zone; and this is of less importance in curved than in direct fire. In the last example the breadth of the danger zone would be

$$X - x = 2.3 \text{ m.}$$

In all operations where curved fire is employed we may determine the breadth of the danger zone with sufficient accuracy by the formula

$$z = y \cot \omega$$

PROBLEM FORTY.

Given: The elements of a horizontal trajectory. Required: The value of θ for any given value of x.

Solution: Solved by equation (50), namely,

$$\tan\theta = \frac{\tan\varphi}{A}(A - a')$$

In this equation A is either taken from Table 1 with the argument X/C; or, if X is not known, A may be computed by the equation

$$A = \frac{\sin 2\varphi}{C}\left(\frac{V}{800}\right)^2$$

a' is to be taken from the "A'" column with the argument x/C.

Approximate Solution for flat trajectories.

We have (see equation (54))

$$\tan\theta = \tan\varepsilon - \tan\omega_x\left(\frac{\cos\varphi_x}{\cos\varphi}\right)^2$$

or, if these angles are all small, we may write, approximately,

$$\theta = \varepsilon - \omega_x$$

The angle ω_x can be taken directly from a table of fire; or it can be computed by either equation (18) or (42) according to the known data.

This approximate method requires that y be first computed by Problem Thirty-eight in order to get ε. It has no advantage over the complete method.

Example 1. Deduce the general expression for θ for the trajectory in which $C = 2$, $X = 4000$ ft. and $\varphi = 10°$. Also compute θ when $x = 3000$ ft. (see Ex. 1, page 45).

Answers.

$$\tan\theta = [0.21665]\,(.10707 - a')$$
$$\theta = -5°\,9'$$

Example 2. Data of Ex. 2, page 45.

Answers.

$$\tan\theta = [9.86899 - 10]\,(.49213 - a')$$
$$\theta = 6°\,5'$$

Example 3. Data of Ex. 3, page 46.

Answers.

$$\tan\theta = [9.82012 - 10]\,(.16590 - a')$$
$$\theta = 5°\,52'\,50''$$

It will be observed that the numerical parts of the general expression for tan θ are the same as those for y; and that the sign of

θ depends upon whether a' is greater or less than A. When these are equal θ becomes zero and the point under consideration is the summit of the trajectory. Finally it may be remarked that the labor of computing θ is not lessened by using the approximate method unless we can take ω_x from a table of fire;—and then but very little.

Solution for metric units.

Compute C, z and A by the formulas of Problems One and Two, and then proceed as for English units. The muzzle velocity can be computed by Problem Three.

Example 4. Deduce the general expression for θ for the trajectory in which $\log C = 0.52562$, $X = 2000$ m, and $\varphi = 10°$. Also compute θ when $x = 1500$ m. (see Ex. 4, page 11).

Solution :

$$
\begin{aligned}
\text{Const. log} &= 0.51599 \\
\log X &= 3.30103 \\
\text{a. c. } \log C &= 9.47438 \\
\hline
\log z &= 3.29140 \\
z &= 1956.15
\end{aligned}
$$

$$\therefore A = .10139 + .5615 \times .00568 = .10458$$

$$
\begin{aligned}
\log \tan \varphi &= 9.24632 \\
\log A &= 9.01945 \\
\hline
& 0.22687
\end{aligned}
$$

$$\therefore \tan \theta = [0.22687]\,(.10458 - a')$$

$$
\begin{aligned}
\text{Const. log} &= 0.51599 \\
\log x &= 3.17609 \\
\text{a. c. } \log C &= 9.47438 \\
\hline
\log z &= 3.16646 \\
z &= 1467.1
\end{aligned}
$$

$$\therefore a' = .1503 + .671 \times .0115 = .1580$$

$$
\begin{aligned}
A &= .10458 \\
a' &= .15800 \\
\hline
\log - .05342 &= 8.72770_n \\
\text{Const. log} &= 0.22687 \\
\hline
\log \tan \theta &= 8.95457_n \\
\theta &= -5° 9'
\end{aligned}
$$

We also find by Problem Three, $V = 247$ m. s.

PROBLEM FORTY-ONE.

Given: The ballistic coefficient, muzzle velocity and rectangular coordinates of any point of a horizontal trajectory. Required: The remaining elements of the trajectory.

Solution: Making

$$\tan \varepsilon = \frac{y}{x}$$

equation (47) becomes

$$\tan \varepsilon = \tan \varphi - \frac{a\,C}{2\cos^2 \varphi}\left(\frac{800}{V}\right)^2$$

If φ_x is the angle of departure for the horizontal range x and given muzzle velocity V, we have by Problem One

$$\sin 2\,\varphi_x = a\,C\left(\frac{800}{V}\right)^2$$

Therefore

$$\tan \varepsilon = \tan \varphi - \frac{\sin 2\,\varphi_x}{2\cos^2 \varphi}$$

or

$$\sin 2\,\varphi - 2\cos^2 \varphi \tan \varepsilon = \sin 2\,\varphi_x \tag{58}$$

But

$$2\cos^2 \varphi = 1 + \cos 2\,\varphi$$

whence

$$\sin 2\,\varphi - \cos 2\,\varphi \tan \varepsilon - \tan \varepsilon = \sin 2\,\varphi_x$$

Multiplying and dividing the first member by $\cos \varepsilon$ we have

$$\frac{\sin 2\,\varphi \cos \varepsilon - \cos 2\,\varphi \sin \varepsilon - \sin \varepsilon}{\cos \varepsilon} = \sin 2\,\varphi_x$$

therefore

$$\frac{\sin (2\,\varphi - \varepsilon) - \sin \varepsilon}{\cos \varepsilon} = \sin 2\,\varphi_x$$

and finally

$$\sin (2\,\varphi - \varepsilon) = \sin \varepsilon\,(1 + \cot \varepsilon \sin 2\,\varphi_x) \tag{59}$$

In computing φ_x by equation (57) a is to be taken from the "A" column of Table 1 with the argument x/C. Having computed φ by equation (59) we then know C, V and φ by means of which the remaining elements of the trajectory passing through the point x, y can be computed by Problem One.

Example 1. $C = 2$, $V = 700$ f. s., $x = 3000$ ft., $y = 1000$ ft.

Here $\tan \varepsilon = \frac{1}{3}$, $\varepsilon = 18° 26' 10''$, $z = 1500$ and $a = 0.07902$.

The computations may conveniently be arranged as follows:

$$\begin{aligned} \log a &= 8.89774 \\ \log C &= 0.30103 \\ 2 \log 800/V &= 0.11598 \\ \hline \log \sin 2\,\varphi_x &= 9.31475 \quad \therefore \varphi_x = 5° 57' 25'' \end{aligned}$$

$$\log \tan \varepsilon = 9.52288$$

$$\log 0.61926 = 9.79187$$

$$\log 1.61926 = 0.20932$$
$$\log \sin \varepsilon = 0.50000$$

$$\log \sin (2\varphi - \varepsilon) = 9.70932$$
$$2\varphi - \varepsilon = 30^\circ\ 48'$$
$$\varepsilon = 18\ \ 26$$

$$2\varphi = 49\ \ 14$$
$$\varphi = 24^\circ\ 37'$$

Example 2. Observations upon the enemy's captive balloon show that the coordinates of its position are $x = 4800$ ft. and $y = 1600$ ft. It is desired to open fire upon it with shell from a field mortar for which $C = 2$ and $V = 800$ f. s. Determine the angle of departure, striking angle, striking velocity and time of flight.

Here $\tan \varepsilon = \frac{1}{3}$, $\varepsilon = 18^\circ\ 26'\ 10''$, $z = 2400$ and $a = .13016$. We find $\varphi = 26^\circ\ 21'\ 25''$, $\theta = 9^\circ\ 8'$, $v = 649$ f. s., $t = 7.1$ sec. and $X = 4277$ yards. The balloon is therefore in the ascending branch of the trajectory, and will be struck from below.

Approximate Solution for flat trajectories.

If the angle of departure φ is small, equation (58) may be written, approximately, (since ε and φ_x are both less than φ),

$$\varphi = \varepsilon + \varphi_x \qquad (60)$$

Example 3. Compute φ by equation (60) with the data of Ex. 1. We have

$$\varepsilon = 18^\circ\ 26'$$
$$\varphi_x = \ \ 5\ \ 57$$

$$\varphi = 24^\circ\ 23'$$

which is 14′ too small. A nearer approximation is obtained by taking instead of x the distance from the gun to the target. Calling this distance s we have

$$s = \sqrt{x^2 + y^2} = x \sec \varepsilon.$$

In Ex. 3 we have $s = 3162.3$, $z = 1581.15$ and $a = .08352$. Therefore $\varphi = 24^\circ\ 44'$ which is to great by 7′.

This is an extreme case. If we make $y = 100$ ft., the other data remaining the same, we shall find by equation (60)

$$\varphi = 7^\circ\ 52'$$

which is but one minute of arc less than that obtained by the complete equation (59).

Solution for metric units.

Compute sin $2\varphi_x$ as explained in Problem Two for metric units and then proceed as for English units.

PROBLEM FORTY-TWO.

Given: The muzzle velocity, angle of projection and rectangular coordinates of the target. Required: The remaining elements of the trajectory.

Solution: From equation (58) we have

$$\begin{aligned} \sin 2\varphi_x &= \sin 2\varphi - 2\cos^2\varphi \tan \varepsilon \\ &= \sin 2\varphi\,(1 - \cot\varphi \tan\varepsilon) \end{aligned}$$

by means of which φ_x can be computed. Then knowing V, x and φ_x we can compute C by Problem Five and then the remaining elements of the trajectory by Problem Two.

Example 1. Firing with a certain gun which gave to the projectile a muzzle velocity of 790 f. s., and with an angle of projection of 10°, the projectile was observed to strike on the side of a bluff 150 feet above the gun and distant 5000 feet (horizontal). What was the ballistic coefficient?

Here $V = 790$ f. s., $\varphi = 10°$, $x = 5000$ ft., $y = 150$ ft. and $\tan\varepsilon = 0.03$.

The work may be conveniently arranged as follows:

$$\begin{array}{rl} \log\tan\varepsilon = & 8.47712 \\ \log\tan\varphi = & \underline{9.24632} \\ \log 0.17014 = & \underline{9.23080} \\ \log 0.82986 = & 9.91900 \\ \log\sin 2\varphi = & \underline{9.53405} \\ \log\sin 2\varphi_x = & 9.45305 \\ 2\log V/800 = & \underline{9.98908} \\ & 9.44213 \\ \log x = & \underline{3.69897} \\ \log C' = & 5.74316 \end{array}$$

$$\begin{array}{rl} \log V = & 2.89763 \\ \log 800 = & \underline{2.90309} \\ & 9.99454 \\ \hline \log x = & 3.69897 \\ \log z = & \underline{3.48187} \\ \log C = & 0.21710 \end{array}$$

$$\therefore z = 3000 + \frac{460}{14} = 3033$$

Solution for metric units.

Compute log sin $2\varphi_x$ as explained above for English units, and then log C by Problem Five, and the remaining elements by Problem Two.

Example 2.* $V = 202$ m. s., $\varphi = 27°$, $x = 3100$ m and $y = 42$ m. Compute log C, X, ω, v and T.

We give the work in full.

$$
\begin{array}{rcl}
\log y & = & 1.62325 \\
\log x & = & 3.49136 \\
\hline
\log \tan \varepsilon & = & 8.13189 \\
\log \tan \varphi & = & 9.70717 \\
\hline
\log 0.02659 & = & 8.42472 \\
\hline
\log 0.97341 & = & 9.98830 \\
\log \sin 2\varphi & = & 9.90796 \\
\hline
\log \sin 2\varphi_x & = & 9.89626 \\
2 \log V & = & 4.61070 \\
\text{Const. } \log & = & 4.70981 \\
\hline
 & & 9.21677 \\
\log x & = & 3.49136 \\
\hline
\log C' & = & 5.72541 \\
\therefore z & = & 1700 + \frac{910}{13} = 1770 \\
\text{Const. } \log & = & 0.51599 \\
\log x & = & 3.49136 \\
\text{a. c. } \log z & = & 6.75203 \\
\hline
\log C & = & 0.75938 \\
\log \tan \varphi & = & 9.70717 \\
\log B' & = & 0.02457 \\
\hline
\log \tan \omega & = & 9.73174 \\
\omega & = & 28° \, 20'
\end{array}
$$

$$
\begin{array}{rcl}
 & (\text{Prob. } 2) & \\
\text{Const. } \log & = & 5.22580 \\
2 \log V & = & 4.61070 \\
\log \sin 2\varphi & = & 9.90796 \\
\text{a. c. } \log C & = & 9.24062 \\
\hline
\log A & = & 8.98508 \\
A & = & 0.09662 \\
\therefore z & = & 1800 + \frac{8800}{565} = 1815.57 \\
\log B' & = & 0.02457 \\
T' & = & 2.369 \\
u & = & 735 \\
\text{Const. } \log & = & 9.48401 \\
\log z & = & 3.25901 \\
\log C & = & 0.75938 \\
\hline
\log X & = & 3.50240 \\
X & = & 3180 \text{ m.} \\
\text{Const. } \log & = & 7.09691 \\
\log V & = & 2.30535 \\
\log u & = & 2.86629 \\
\log \cos \varphi & = & 9.94988 \\
\log \sec \omega & = & 0.05542 \\
\hline
\log v & = & 2.27385 \\
v & = & 187.9 \text{ m. s.} \\
\text{Const. } \log & = & 2.38710 \\
\log C & = & 0.75938 \\
\log T' & = & 0.37457 \\
\text{a. c. } \log V & = & 7.69465 \\
\log \sec \varphi & = & 0.05012 \\
\hline
\log T & = & 1.26582 \\
T & = & 18.44 \text{ sec.}
\end{array}
$$

PROBLEM FORTY-THREE.

Given: The ballistic coefficient, angle of departure and rectangular coordinates of the target. Required: The remaining elements of the trajectory.

---

[*] Vallier, *Balistique Expérimentale*, page 109.

Solution: Compute $\sin 2\varphi_x$ as in Problem Forty-two. Then with C, x and φ_x compute V and the remaining elements by Problem Three, changing A to a and $\sin 2\varphi$ to $\sin 2\varphi_x$.

Example 1. Firing with a howitzer for which $C = 2$, and with an angle of departure of 15° the projectile was observed to strike on the side of a bluff 200 feet above the gun and distant 2400 yds. (horizontal). What was the muzzle velocity?

Here $C = 2$, $\varphi = 15°$, $x = 7200$ ft., $y = 200$ ft., $\tan \varepsilon = 1/36$, $z = 3600$ and $a = 0.20304$.

$$
\begin{array}{rl}
\log \tan \varepsilon = & 8.44370 \\
\log \tan \varphi = & \underline{9.42805} \\
\log 0.10367 = & \underline{9.01565} \\
\log 0.89633 = & 9.95247 \\
\log \sin 2\varphi = & \underline{9.69897} \\
\log \sin 2\varphi_x = & 9.65144 \quad \varphi_x = 13° \, 19' \\
\log a\,C = & \underline{9.60861} \\
2\,)\!\!\!\! & \underline{9.95717} \\
 & 9.97858 \\
\log 800 = & \underline{2.90309} \\
\log V = & 2.88167 \\
V = & 761.5 \text{ f. s.}
\end{array}
$$

It will be observed that φ_x, or rather $\log \sin 2\varphi_x$, is used simply as an auxiliary quantity.

This is an easy and accurate solution of an important problem. There is no saving of labor by computing φ_x by the approximate equation (60).

Example 2. Referring to Ex. 2, page 52, suppose the mortar were given the customary elevation of 45°, what muzzle velocity would be required to hit the balloon?

Here $C = 2$, $\varphi = 45°$, $x = 4800$ ft., $y = 1600$ ft., $\tan \varepsilon = \frac{1}{3}$, $z = 2400$ and $a = .13016$.

We find $V = 499.9$ f. s. and $\theta = -21° \, 3'$. The balloon is in the descending branch of this trajectory, and will be struck from above.

Solution for metric units.

Proceed as in Problems Forty-two, Three and One.

Example 3. $C = 5$, $\varphi = 20°$, $x = 3500$ m, $y = 50$ m.

Solution:

$\log y = 1.69897$
$\log x = 3.54407$

$\log \tan \varepsilon = 8.15490$
$\log \tan \varphi = 9.56107$

$0.03925 = 8.59383$

$0.96075 = 9.98261$
$\log \sin 2\varphi = 9.80807$

$\log \sin 2\varphi_x = 9.79068$
$\log aC = 9.79285$
$2\,)\,0.00217$
0.00108 (Prob. 3.)
Const. $\log = 2.38710$

$\log V = 2.38818$
$V = 244.4$ m. s.

Const. $\log = 0.51599$
$\log x = 3.54407$ (Prob. 1.)
a. c. $\log C = 9.30103$

$\log s = 3.36109$
$s = 2296.6$
$\therefore\ a = .11854 + .966 \times .00579$
$= .12413$
$aC = .62065$

PROBLEM FORTY-FOUR.

Given: The ballistic coefficient, the rectangular coordinates of a target above (or below) the level of the gun and the striking velocity. Required: The remaining elements of the trajectory.

Solution:

Equation (5) can be written for any muzzle velocity V less than 800 f. s.,

$$u = v \sec \varphi \cos \theta \left(\frac{800}{V}\right)$$

where u, v and θ refer to the point of the trajectory x, y, that is, to the target. From this we find

$$V = v \sec \varphi \cos \theta \left(\frac{800}{u}\right)$$

Of the factors comprised in the second member of this last equation we know v, and u can be taken from Table 1 with the argument x/C. We do not know the angles φ and θ, but for a first approximation we may assume

$$\sec \varphi \cos \theta = 1$$

and compute V by the approximate formula

$$V = \frac{800\,v}{u}$$

Next compute φ and θ by Problems Forty-one and Forty, and then V by the complete formula given above. It will generally be necessary to repeat this operation once more in order to get the correct value of V. Knowing C, V and φ the remaining elements can be computed by Problem Two. There is one point in the descending branch where the assumption made above with reference to the angles θ and φ is correct, namely, at the point where

$$\theta = -\varphi$$

To determine the coordinates of this point we have from equation (50) by making

$$\tan\theta = -\tan\varphi$$

the necessary condition

$$a' = 2A$$

Example. In Ex. 2, Problem Fifteen, suppose the place selected for the gun had been 1875 yards from the escarp to be breached and 100 feet below it. What muzzle velocity and angle of departure would have been necessary to secure a striking velocity of 600 f. s., and what would the striking angle have been?

Here $\log C = 0.40333$, $x = 5625$ ft., $y = 100$ ft., $v = 600$ f. s. and $\varepsilon = 1^\circ\, 1'\, 7''$. We have

$$z = \frac{x}{C} = 2222.2$$

$$u = 721$$

$$V = \frac{800 \times 600}{721} = 666$$

With this value of V we find $\varphi = 14^\circ\, 3'$ and $\theta = -13^\circ\, 2'$. Making the proper corrections we next have $V = 668.6$ f. s , $A = .12909$, $a' = .24830$, $\varphi = 13^\circ\, 57'$ and $\theta = -12^\circ\, 55'$. These results need no further correction.

Example 2. Determine the coordinates of the point of the trajectory of Ex. 1 for which

$$\theta = -\varphi$$

Making

$$a' = 2A = .25818$$

we find from Table 1

$$z = 2300 + \frac{280}{125} = 2302.24$$

and

$$a = .12433 + .0224 \times .00583 = .12446$$

Substituting these values in equation (53) we have

$$\log\tan\varepsilon = 7.95307 - 10$$

We also have from equations (1) and (13)

$$x = Cz$$

and from equations (49) and (53)

$$y = x \tan \varepsilon$$

Therefore $x = 5827$ ft. and $y = 52.3$ ft.

Solution for metric units.

The expression for tan ε is independent of the units employed, and also V, if log C and z are computed by the formulas of Problem One.

PROBLEM FORTY-FIVE.

Given: C, x, y, θ. Required: The remaining elements of the trajectory.

Solution: By a proper combination of equations (47) and (48) we obtain the relation

$$\tan \varphi = \frac{1}{b'} (\tan \varepsilon - \tan \theta) + \tan \varepsilon \tag{61}$$

and from equation (53)

$$A = \frac{a \tan \varphi}{\tan \varphi - \tan \varepsilon}$$

The remaining elements can now be computed by Problem Three.

The above expression for tan φ can be transformed to

$$\tan \varphi = (\tan \varepsilon - \tan \theta) \frac{\tan \omega_x}{\tan \varphi_x} + \tan \varepsilon$$

which, when the angles φ_x and ω_x do not differ greatly from each other, or in other words, when b' is near unity, may be written

$$\tan \varphi = 2 \tan \varepsilon - \tan \theta \tag{62}$$

or, if all the angles and muzzle velocity are small, we may have

$$\varphi = 2 \varepsilon - \theta \tag{63}$$

In using equation (61) we must take log b' from the "log B" column of Table 1 with the argument $z = x/C$. The tangents of the angles can be taken from Table 4.

Example 1. $C = 2$, $x = 3000$ ft., $y = 300$ ft., $\theta = -10°$.

$$\textit{Solution}: \quad z = \frac{3000}{2} = 1500$$

$$\therefore a = 0.07902$$
$$\log b' = 0.02031$$

$$\begin{aligned}
\tan\varepsilon &= 0.10000\\
\tan\theta &= -\,0.17633\\
\hline
\log 0.27633 &= 9.44143\\
\log b' &= 0.02031\\
\hline
\log 0.26371 &= 9.42112 = \log(\tan\varphi - \tan\varepsilon)\\
\tan\varepsilon &= 0.10000\\
\hline
\tan\varphi &= 0.36371 \qquad \therefore\ \varphi = 19^\circ\ 59'
\end{aligned}$$

$$\begin{aligned}
\log a &= 8.89774\\
\log\tan\varphi &= 9.56067\\
\text{a. c. } \log(\tan\varphi - \tan\varepsilon) &= 0.57888\\
\hline
\log A &= 9.03729\\
\log C &= 0.30103\\
\text{a. c. } \log\sin 2\varphi &= 0.19223\\
\hline
&2\,)9.53055\\
&9.76527\\
\log 800 &= 2.90309\\
\hline
\log V &= 2.66836\\
V &= 466 \text{ f. s.}
\end{aligned}$$

Therefore the projectile of this example would have to be fired with an angle of departure of 19° 59′ and a velocity of 466 f.s. in order to pass through the given point with the given inclination.

By equation (62) we have as follows:

$$\begin{aligned}
2\tan\varepsilon &= 0.20000\\
\tan\theta &= -\,0.17633\\
\hline
\tan\varphi &= 0.37633\\
\varphi &= 20^\circ\ 37'
\end{aligned}$$

differing by 38′ from the complete solution. The error by using equation (63) would be still greater, namely, 1° 26′. It may be remarked that equation (62) is the solution of this problem by the parabolic theory, and therefore by employing it we throw out the resistance of the air.

The expression for the muzzle velocity in the parabolic theory for this problem is

$$V^2 = \frac{g\,x\cos\varepsilon}{2\cos\varphi\sin(\varphi - \varepsilon)}$$

which gives for the data of Ex. 1, $V = 446.6$ f. s. Leaving out the resistance of the air then reduces muzzle velocity, which is what one would expect; but it also increases the angle of departure.

Example 2. In Ex. 2, Problem Fifteen suppose that with reference to the place selected for the gun the coordinates of the point to be breached are $x = 1875$ yds. and $y = 100$ ft. If the angle of descent must necessarily be 14°, what will be the muzzle velocity, angle of departure and striking velocity?

Here $\log C = 0.40333$, $x = 5625$ ft., and $y = 100$ ft.

Answers. $V = 645.9$ f. s., $\varphi = 14° 57'$ and $v = 575.9$ f. s.

Example 3. Referring to Ex. 2, suppose the gun to be 100 feet above the level of the point to be breached, the other data remaining the same.

Here $y = -100$ ft.

Answers. $V = 683.3$ f. s., $\varphi = 11° 13'$ and $v = 627.7$ f. s.

Solution for metric units.

Compute $\log C$ and z as in Problem One, φ as explained above for English units, A by Problem Two and V by Problem Three.

Example 4.* In preparing to breach a certain escarp suppose there are found two practicable positions for the guns, and we wish to determine which of the positions is best for the purpose. The data for the two positions as determined by the Engineers, are as follows, designating the two positions by A and B:

Position A.	*Position B.*
$x = 2485$ m	$x = 1040$ m
$y = 55.12$ m	$y = -27.88$ m
$\theta = -12° 16'$	$\theta = -12° 34'$
$\tan \varepsilon = 0.02218$	$\tan \varepsilon = -0.02681$

For the gun we have

$$d = 21 \text{ cm}$$
$$w = 78.75 \text{ kg}$$
$$c = 1.215$$
$$\text{whence, } \log C = 0.32022$$

We give the computations for the angles of projection and muzzle velocities in full.

---

* The data for this example are taken from Colonel La Llave's *Problemas de Balistica aplicados a la Fortificacion y a la Tactica.* Madrid, 1896, page 123, *et seq.*

Position A.	*Position B.*
Const. $\log = 0.51599$	Const. $\log = 0.51599$
$\log x = 3.39533$	$\log x = 3.01703$
a. c. $\log C = 9.67978$	a. c. $\log C = 9.67978$
$\log z = 3.59110$	$\log z = 3.21280$
$z = 3900.3$	$z = 1632.3$
$u = 666.6$	$u = 741.3$
$a = .22217$	$a = .08636$
$\log b' = 0.05275$	$\log b' = 0.02210$
$\tan \varepsilon = 0.02218$	$\tan \varepsilon = -0.02681$
$\tan \theta = -0.21743$	$\tan \theta = -0.22292$
$\log 0.23961 = 9.37950$	$\log 0.19611 = 9.29250$
$\log b' = 0.05275$	$\log b' = 0.02210$
$\log 0.21220 = 9.32675$	$\log 0.18638 = 9.27040$
$\tan \varepsilon = 0.02218$	$\tan \varepsilon = -0.02681$
$\tan \varphi = 0.23438$	$\tan \varphi = 0.15957$
$\varphi = 13^\circ\ 11'.4$	$\varphi = 9^\circ\ 4'$
$\log a = 9.34669$	$\log a = 8.93631$
$\log \tan \varphi = 9.36989$	$\log \tan \varphi = 9.20297$
a.c. $\log(\tan \varphi - \tan \varepsilon) = 0.67325$	a.c. $\log(\tan \varphi - \tan \varepsilon) = 0.72960$
$\log A = 9.38983$	$\log A = 8.86888$
$\log C = 0.32022$	$\log C = 0.32022$
a. c. $\log \sin 2\varphi = 0.35230$	a. c. $\log \sin 2\varphi = 0.50692$
2)0.06235	2)9.69602
0.03117	9.84801
Const. $\log = 2.38710$	Const. $\log = 2.38710$
$\log V = 2.41827$	$\log V = 2.23511$
$V = 262.0$ m. s.	$V = 171.8$ m. s.
$\log V = 2.41827$	$\log V = 2.23511$
$\log u = 2.82387$	$\log u = 2.86999$
$\log \cos \varphi = 9.98839$	$\log \cos \varphi = 9.99454$
$\log \sec \theta = 0.01003$	$\log \sec \theta = 0.01053$
a. c. $\log 800 = 7.09691$	a. c. $\log 800 = 7.09691$
$\log v = 2.33747$	$\log v = 2.20708$
$v = 217.5$ m. s.	$v = 161.1$ m. s.

$$\log v^2 = 4.67494$$
$$\log w = 1.89625$$
$$\text{a. c. } \log 2g = 8.70730$$
$$\text{a. c. } \log 1000 = 7.00000$$
$$\log 189.89 = 2.27849$$

The striking energy of the projectile is therefore 189.89 metre-tonnes.

$$\log v^2 = 4.41416$$
$$\log w = 1.89625$$
$$\text{a. c. } \log 2g = 8.70730$$
$$\text{a. c. } \log 1000 = 7.00000$$
$$\log 104.16 = 2.01771$$

The striking energy of the projectile is therefore 104.16 metre-tonnes.

If the breach is to be 6 metres high and 20 metres broad the volume of masonry to be demolished is 210 cubic metres.

According to the experiments made by the Prussians at Graudenz in 1875 there are required 132 metre-tonnes of energy for each cubic metre to be demolished. The total energy necessary to effect the breach is therefore

$$210 \times 132 = 27720 \text{ metre-tonnes.}$$

The number of projectiles that must hit the target is, then, as follows:

$$\text{Fired from position A, } \frac{27720}{189.99} = 146$$

$$\text{Fired from position B, } \frac{27720}{104.16} = 266$$

To determine the number of shots that must be fired from each position to effect the breach we must know the probability of hitting a rectangle 6 m by 20 m from each of the two positions. The mean vertical and horizontal quadratic deviations for the gun in question are known by previous experiments to be as follows for the two positions:

Position A.	*Position B.*
$E_x = 4.74$ m	$E_x = 2.18$ m
$E_y = 2.18$ m	$E_y = 0.83$ m

The horizontal, or lateral, deviations (E_y) are so small relatively to the breadth of the target that we may consider the probability of the vertical zone as unity. The probability for the horizontal zone is found from the table on page 225 of the Handbook. We have for

Position A.	*Position B.*
$\frac{6}{E_x} = 1.27$	$\frac{6}{E_x} = 2.75$
$P = .4745$	$P = .8308$
$\frac{146}{.4745} = 308$	$\frac{266}{.8308} = 321$

It will therefore require at least 308 shots from position A and 321 from position B to effect the breach. The position A is by these calculations slightly superior to B from a ballistic point of view. The above computations agree substantially with those made by La Llave.

PROBLEM FORTY-SIX.

To determine the elements of a trajectory for a given projectile which shall pass through two given points.

Solution: Let x, y and x_1, y_1 be the two given points, and ε, ε_1 their angular elevations (or depressions) above (or below) the level of the gun. Then

$$\tan \varepsilon = \frac{y}{x}$$

and

$$\tan \varepsilon_1 = \frac{y_1}{x_1}$$

From equation (53) we have

$$\tan \varepsilon = \frac{\tan \varphi}{A} (A - a)$$

and

$$\tan \varepsilon_1 = \frac{\tan \varphi}{A} (A - a_1)$$

In these equations a is to be taken from the "A" column with the argument

$$z = \frac{x}{C}$$

and a_1 with the argument

$$z_1 = \frac{x_1}{C}$$

Solving for A and $\tan \varphi$ we have

$$A = \frac{a_1 \tan \varepsilon - a \tan \varepsilon_1}{\tan \varepsilon - \tan \varepsilon_1}$$

and

$$\tan \varphi = \frac{A \tan \varepsilon}{A - a} = \frac{A \tan \varepsilon_1}{A - a_1}$$

Knowing C, φ and A the remaining elements of the trajectory can be computed by Problem Three. It will be observed that all the formulas of this problem are independent of the muzzle velocity.

Example 1. $C = 2$, $x = 1800$ ft., $y = 50$ ft., $x_1 = 2200$ ft., $y_1 = -10$ ft.

We find

$$z = 900 \qquad \tan \varepsilon = \frac{1}{36}$$
$$a = .04652$$
$$z_1 = 1100 \qquad \tan \varepsilon_1 = -\frac{1}{220}.$$
$$a_1 = .05722$$

Substituting these numbers in the expressions for A and $\tan \varphi$ we have

$$A = \frac{220 \times .05722 + 36 \times .04652}{220 + 36} = .055715$$

$$\tan \varphi = \frac{.055715}{36 \times 009195} = .16831$$

$$\therefore \varphi = 9^\circ\ 31'$$

Next by the formula

$$V = 800 \left(\frac{A\ C}{\sin 2\ \varphi}\right)^{\frac{1}{2}}$$

we find

$$V = 466.6 \text{ f. s.}$$

All the other elements can now be computed by methods already explained and illustrated.

By the parabolic theory the expressions for $\tan \varphi$ and V are

$$\tan \varphi = \frac{x_1 \tan \varepsilon - x \tan \varepsilon_1}{x_1 - x}$$

and

$$V^2 = \frac{g\ (x_1 - x)}{2 \cos^2 \varphi\ (\tan \varepsilon - \tan \varepsilon_1)}$$

These formulas give with the data of this example

$$\varphi = 9^\circ\ 49'\ 40''$$
$$V = 452.7 \text{ f. s.}$$

Solution for metric units.

With metric units z and z_1 will be computed by Problem One.

JAMES M. INGALLS,
Major, First Artillery.

[A revised, enlarged and rewritten edition of the original article which appeared in January-February 1898 number *Journal U. S. Artillery.*]

Z	*u*	*D*	log *C′*	*D*	log *C″*	*D*	log *C‴*	*D*
			—10		—10			
100	796.3	−3.7	5.7026	13	8.30352	34	1.5066	−6
200	792.6	3.7	5.7039	14	8.30386	34	1.5060	7
300	788.9	3.7	5.7053	13	8.30420	35	1.5053	7
400	785.2	3.[illegible]	5.7066	14	8.30455	34	1.5046	7
500	781.6	3.[illegible]	5.7080	14	8.30489	35	1.5039	6
600	777.9	3.[illegible]	5.7094	13	8.30524	35	1.5033	7
700	774.3	3.[illegible]	5.7107	14	8.30559	35	1.5026	7
800	770.7	3.[illegible]	5.7121	13	8.30594	35	1.5019	6
900	767.1	3.[illegible]	5.7134	14	8.30629	35	1.5013	7
1000	763.5	3.[illegible]	5.7148	14	8.30664	35	1.5006	7
1100	759.9	3.[illegible]	5.7162	14	8.30699	36	1.4999	6
1200	756.4	3.[illegible]	5.7176	13	8.30735	35	1.4993	7
1300	752.9	3.[illegible]	5.7189	14	8.30770	36	1.4986	7
1400	749.4	3.[illegible]	5.7203	14	8.30806	36	1.4979	6
1500	745.9	3.[illegible]	5.7217	14	8.30842	36	1.4972	6
1600	742.4	3.[illegible]	5.7231	14	8.30878	36	1.4966	7
1700	738.9	3.[illegible]	5.7245	13	8.30914	36	1.4959	7
1800	735.5	3.[illegible]	5.7358	14	8.30950	36	1.4952	6
1900	732.0	3.[illegible]	5.7272	14	8.30986	37	1.4946	7
2000	728.6	3.[illegible]	5.7286	14	8.31023	37	1.4939	7
2100	725.2	3.[illegible]	5.7300	14	8.31060	37	1.4932	6
2200	721.8	3.[illegible]	5.7314	14	8.31097	37	1.4926	7
2300	718.4	3.[illegible]	5.7328	14	8.31134	37	1.4919	6
2400	715.1	3.[illegible]	5.7342	14	8.31171	37	1.4913	7
2500	711.8	3.[illegible]	5.7356	15	8.31208	37	1.4906	7
2600	708.4	3.[illegible]	5.7371	14	8.31245	38	1.4899	6
2700	705.1	3.[illegible]	5.7385	14	8.31283	37	1.4893	7
2800	701.8	3.[illegible]	5.7399	14	8.31320	38	1.4886	6
2900	698.6	3[illegible]	5.7413	14	8.31358	38	1.4880	7
3000	695.3	3.[illegible]	5.7427	14	8.31396	38	1.4873	7
3100	692.0	3.[illegible]	5.7441	15	8.31434	38	1.4866	6
3200	688.8	3.[illegible]	5.7456	14	8.31472	38	1.4860	7
3300	685.6	3.[illegible]	5.7470	14	8.31510	39	1.4853	6
3400	682.4	3.[illegible]	5.7484	14	8.31549	38	1.4847	7
3500	679.2	3.[illegible]	5.7498	15	8.31587	39	1.4840	7
3600	676.0	3.[illegible]	5.7513	14	8.31626	39	1.4833	6
3700	672.9	3[illegible]	5.7527	14	8.31665	39	1.4827	7
3800	669.7	3[illegible]	5.7541	15	8.31704	39	1.4820	6
3900	666.6	3[illegible]	5.7556	14	8.31743	39	1.4814	7
4000	663.5	3[illegible]	5.7570	14	8.31782	39	1.4807	7
4100	660.4	3[illegible]	5.7584	15	8.31821	40	1.4800	6
4200	657.3	3[illegible]	5.7599	14	8.31861	40	1.4794	7
4300	654.3	3[illegible]	5.7613	15	8.31901	40	1.4787	6
4400	651.2	3[illegible]	5.7628	14	8.31941	40	1.4781	7
4500	648.2	3[illegible]	5.7642	15	8.31981	40	1.4774	6

COAST DEFENSE AGAINST TORPEDO-BOAT ATTACK.

BY MAJOR-GENERAL J. B. RICHARDSON.

During the last few years, thanks to the cordial co-operation of the naval authorities, considerable experience has been gained at Gibraltar in the matter of attacking shipping by torpedo boats and in repelling these attacks by Q. F. guns, both in moonlight and with electric lights. In the belief that this experience, and deductions made by its aid, may prove interesting and instructive to the artillery generally, this paper is put forward.

To the naval man, defense against torpedo-attack is a vital matter, and receives earnest attention. His existence may depend on his ability to keep exceedingly fast but small boats, at a distance of, say 1,000 yards from his ship. He naturally maintains all means of doing so, of which he knows, in a very high state of efficiency by constant trial and practice. A free hand is given him, and he has everything under his undivided control. Scouts may be out in the shape of destroyers, torpedo-boats, guard-boats, etc., but he does not trust only to these; attacking boats may slip through such outposts and he then relies on a great mass of what is practically, except as regards direction, unaimed fire, from light Q. F. and machine guns, aided by electric lights, nets, etc., all under his own hand. Looking to the value of his charge, he is granted a considerable amount of ammunition for the practice which can alone make his defense perfect; and he is little hampered by the need of reference, that curse of the Army. He has a serious business to perform and he does not mince matters. In his own element, the open sea, his precautions probably enable him to beat off torpedo-boat attacks with ease, the balance of probability being decidedly in his favor. As he approaches narrow waters his chances of successful defense diminish; and his individual powers are at a minimum when his ship is at rest in a crowded harbor, though he can surround himself with obstructions, and can then, in many places, be very excellently defended from the shore.

Trained to rely on himself, for the most part, the naval officer knows very little, and believes less in the powerful aid shore batteries can render him, yet on the very few occasions in which the navy and coast artillery have been enabled to work together, though he exhibits contempt for the system which cripples the shore artillery, by making them entirely dependent for their efficiency on a variety of departments working independently of them, and also in the numerical weakness of their armament, his views as to the part they could undertake in keeping him free from attack if they were properly practiced and given the free hand he himself gets, undergo a considerable modification. Accustomed to fire from guns on a low level the naval officer credits the striking power of all guns high or low as about equal, but he now sees the very much greater certainty with which shells can be made to strike small moving objects when fired from guns on a high site; the advantages they would possess if auto-sighted over his own low-sighted guns, and the enormously better field of view which they obtain at night over the sea. The gain in having the electric light on a steady platform and the possibility of placing it at the best height for the guns to act commends itself to him. The height of his own lights, like that of his guns, being limited.

Torpedo boats can, in themselves, do no harm to shore defenses. Perhaps, as a consequence, garrison artillery are apt to treat that part of their work which deals with resistance to their raids as a matter of comparatively light importance. In reality it is a difficult, and by no means light duty; one which, at a great number of stations, would be the first called into play in the event of war, and a task which requires the very greatest efficiency, both of *personnel* and *matériel*, to be of any use whatever on most nights in the year. Yet, given reasonably placed Q. F.'s and facilities for using them such as modern artillery science can readily provide, it should be a disgrace to them if they allow a boat to slip in and do damage on any fairly clear night. A heavy armament appeals much more strongly to the imagination both of gunners and the public, but, as far as regards attack by ships, if heavy guns are at all well sited and mounted, they can only be effectively engaged by day, when they have a large, easily seen target, much more vulnerable than themselves and one which they can batter with every advantage on their side except choice of time. The enormous amount of ammunition expended by the American fleet in Cuba against a feeble armament, chiefly mounted on heights in improvised defenses, without any corresponding result, is sufficient to show the advantages shore defenses possess.

The siting of light Q. F. guns and that of electric lights in any given fortress so as to oppose the greatest possible difficulties to the safe approach of torpedo boats is, owing to the many unexpected complications which crop up, a very difficult problem when attempted from an office desk. General rules have been sought from trials here and there, but generally from too limited an experience, these frequently break down when applied to a fresh situation, and there appears but one satisfactory method of arriving at a solution of the problem for any particular locality, that of practical trial on the spot, a method which so often upsets plausible theories. The two things, guns and lights, hang so much on one another that it appears fatal to separate them, as is done in our service. The lights (except on a mine field) are absolutely no use without the guns, and the guns on many nights in the year are useless without the closest co-operation of the lights. Without such intimate co-operation the lights may, and at present frequently do prevent the guns acting at all, though the guns could sometimes be effective if the lights were not there.

There seems to be a prevalent notion that torpedo-boat attack can be met with a sort of "go as you please" system of guns and lights, that in fact each quick-firing battery and electric light installation will be most effective if left entirely to itself, uncontrolled and unaided. Maneuvers of any reasonable numbers of guns, lights and torpedo-boats working at one time show its fallacy. This unfortunate idea has crept in from the use of quick-firing batteries close to the water's edge, whence they can see little or nothing at night, while their fire is almost unaimed. It is then possible for control to be useless. A very little practical work at maneuvers with reasonably sited guns suffices to prove that the old maxim 'unity is strength' is true in counteracting torpedo-boat attacks, as it is in all other military operations. Torpedo-boats will slip in with ease through a disjointed defense when the attack is made by a combination of these vessels. Light quick-firing batteries sufficiently close to each other to fire into the same water areas will be comparatively ineffective, unless they are under very instantaneous and strict control. This is best effected, in most cases, by placing a superior artillery officer at some central station as a superintendent of gun fire. He should be able to see most, if not all, the water covered by his guns, and it is a distinct advantage if he can also see the positions of the quick-firing batteries themselves; it aids his decision when he knows what battery is firing. The central station must act as a sort of intelligence department to all its branches, it should receive reports, sift true from false, have the power of instantaneously checking or releasing fire, and of, somewhat less rapidly perhaps, warning batteries when it is discovered that boats are about, telling them the direction in which they were last seen. The central station should be on the highest available ground; it should be fitted with a C.O.'s P.F. instrument, (or if on a very high site even a simpler means of giving bearing and range) and a large chart furnished with small leaden blocks representing torpedo-boats; by means of which the number of torpedo-boats about will soon be conjectured as reports come in; even the plan of attack of the boats may gradually be worked out. The look out of the station must have the bell pushes of each battery of guns and of the electric lights close to his hand and distinguishable by the feel, for the lookout station itself must be in absolute darkness.

To convince anyone of the necessity for control it is usually sufficient to open fire from a number of absolutely independent batteries of quick-firing guns, at a fairly fast target in broad daylight. No battery, except such as are very high sited, say 600 feet, can distinguish its own shots and the means of ranging and hitting is removed. Very low sited quick-firers often never get on the target at all. If there is this confusion when working with the easiest possible of lights, what reasonable certainty of striking torpedo-boats can be looked for when the difficulties of seeing are enormously increased? There can at best, under such circumstances, be a mere dependance on a mass of what is practically unaimed fire for which the number of guns usually supplied to fortresses is inadequate, and an abandonment of the advantages coast batteries possess over shipping; a waste in fact of artillery science. It is more probable that a torpedo-boat would be sunk or put out of action at night, by one battery of two well placed and well handled quick-firing guns, having the water area to itself, than by four or more quick-firing batteries firing on the "go as you please" system laid down for us.

Undoubtedly any attempt to control light quick-firing batteries in little details is wrong, as it also is with heavier armaments if the *personnel* is well trained. Over contrcl leads to dreadful slowness, and has been brought about by the natural nervousness of artillery officers when firing from guns manned by but partially trained gunners. But quick-firing batteries for night work must have well trained men to do any good at all, and it does not take long to train them with a little firing. Their opportunity for real work will not perhaps exceed three or four minutes at a time, for a boat will either run in or sheer off beaten back in that time, and to attempt to regulate fire in detail by a central authority, however clever and practiced, would be to render the guns inoperative. Guns, even if supplied with auto-sights, must be ranged and those in charge of them must be given the opportunity of picking up accurate shooting.

The following method of working several quick-firing batteries is suggested as affording a very effective control. A central station for each distinct area under an experienced senior artillery officer, supplied with a reasonable staff of an officer, lookout and telephone men, glasses, instruments, charts, etc. This station must be in communication with each battery of quick-firing guns, and with each of the available electric beams, by means of an electric bell and a telephone. Guns and lights to have any chance of beating off an enterprising attack *must* be worked together for that common purpose.

Perhaps a descriptive suggestion of the working of such a station, founded on actual occurrences during a week of maneuvers, may assist in understanding the system recommended. At these maneuvers, however, though there were many more lights than those shown, only one moving beam was actually under the control of the central station; the others, and some of the batteries, worked independently and the lights in consequence often prevented the low sited guns seeing to fire. I take for simplicity's

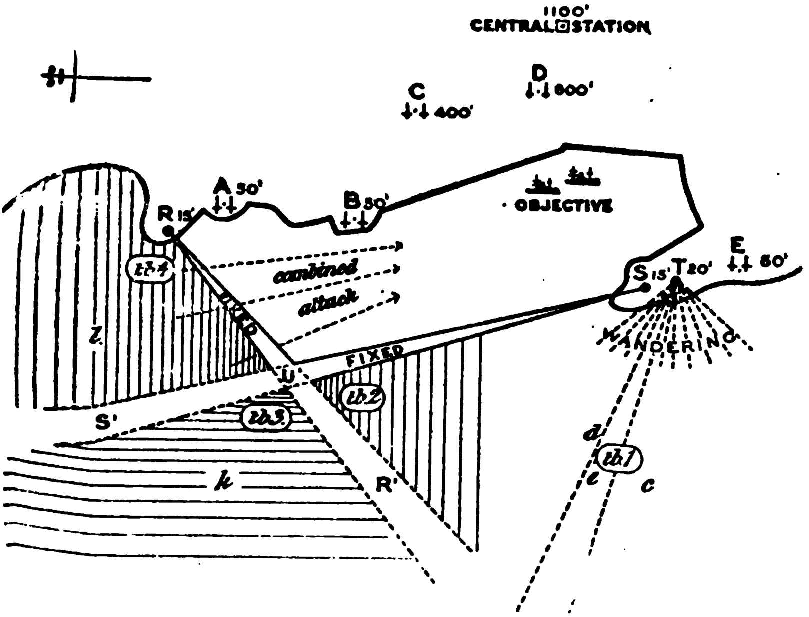


Fig. 1.

sake only three lights, all low sited and five 2-gun quick-firing batteries at various heights.

Thus *R* and *S* are, in accordance with existing engineer methods, fixed lights. *T* was a wandering beam rigged up ashore by the navy, beautifully worked by their men, and under the complete control of the central station by means of an electric bell. It, too, was low sited, but slightly higher than the two fixed lights. With the selection of position of electric lights the artillery have unfortunately nothing to say. The example given is perhaps an instance of the worst possible arrangement, but is all the more instructive. The attack was made by four boats.

The night—pitch dark. The two batteries, *A* and *B*, can see nothing outside the fixed rays *R U*, *S U*, being blinded by these fixed lights, and they are useless until the boats run through the fixed beams. *E* is also blinded when the wandering ray moves to the southward. Suppose a boat *t. b. 1* is picked up in the wandering ray *T*. *C* and *D*, seeing over the fixed rays *R U*, *S U*, and *E* at once open fire. The three batteries see many splashes (say *c*, *d*, *e*,) but none of them ean tell which are its own splashes, and each is apt to alter wrongly. Seeing an absence of splashes in the exact neighborhood of the boat, the central authority touches *D's* and *E's* bell, and they cease fire ; *C* at once ranges ; *D's* bell is touched half a-minute after and recommences fire ; having been short before, *D* can probably now range as *C's* splashes should be close to the boat, but if not *C* is stopped for a very short time, and so on, the fire of the batteries which have had the chance of ranging being effective out of all comparison with the unranged batteries. With auto-sights the system should be doubly valuable, as then once "on" will mean always "on," and a boat appreciating the increased accuracy will turn and go to sea, or rush for dark water as at *K* if it knows of it. Good practice from high sited 12-pounder quick-firing guns up to 5,000 yards may in this way be calculated on ; at ranges of 4,000 and upwards however, rather more than half a minute must be allowed for ranging owing to increased time of flight. At long ranges there is not so much occasion for hurry, you may not so certainly sink the boat, but she can do no harm.

Suppose the boat *t.b.* had not been picked up by the wandering ray and, working in concert with others, she had been specially detailed to get as close as possible to the light *R* with a view to a combined attack from the north, through the ray *R U*, on the objective ships. She runs to *t.b. 2*, waits till the carbon of *R* needs adjustment and passes through to the dark water at *K*, say to *t.b. 3*, where she waits in perfect security, *R* and *S* being fixed lights, until the carbon of *S* also needed a change. Then she passes to the dark water *l* to rest until one or more of her consorts join her when, the rush being decided on, she moves to *t.b. 4* and fires shadow-laying at the light, attracting much attention on herself. Whether successful or not in destroying the light with her small quick-firers and rifles in a minute or so, she and her consorts, each a few hundred yards apart, must make their rush and, if batteries are working independently, with a good chance of success. *A*, *B*, *C*, *D* and one gun of *E*, all see them, but there is a strong tendency always exhibited to fire at the most easily seen boat, and one of the three boats at any rate should get home. One boat is left out with instructions to show showers of sparks from her funnel and attract the attention of the wandering beam as soon as she hears *t.b. 4* commence firing at the light. The central station, however, knowing her range and that she cannot get home for several minutes, neglects her and turns the wandering ray on the real attack preventing the rushing boats seeing their objective. The central observer would moreover see which boats were not receiving proper attention and turn at least one battery on any boat near which he saw no shell falling. Attacks differ greatly, the above is founded on an actual attack made.

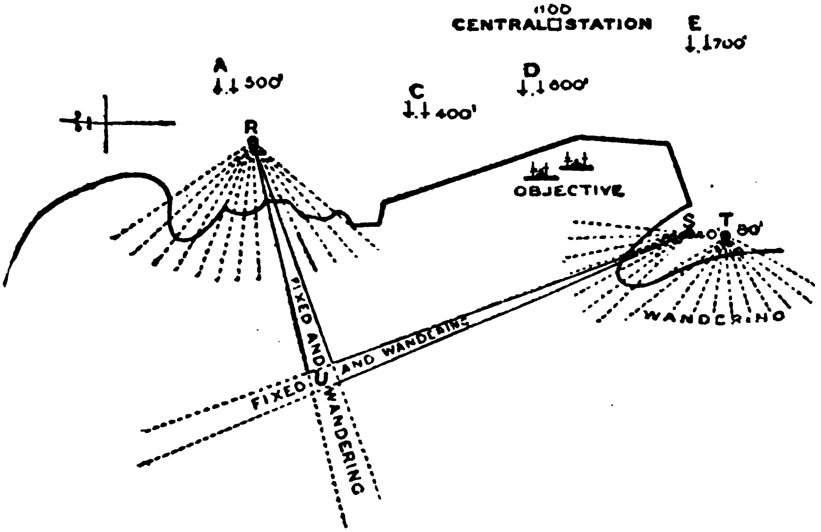


Fig. 2.

In this case there are perhaps plenty of guns but not sufficient electric lights available to beat off a well planned combined attack of four or five boats with any certainty, yet with a different siting of fewer guns and the same lights such an attack would have little chance of success. Thus as in Fig. II, *A* and *E* batteries might be thrown back on to heights to see over the rays. *B* could even be dispensed with. The lights all thrown back a little and raised while, though their general function may be to act as fixed lights, the central station must have the power of traversing them and changing the position of *U.* It is evident that the director of fire has now eight guns, instead of four, to act with from the very first, and the light *R* can, as it were, now defend itself. If the reader will take the trouble to repeat the incidents of the attack he will see that the central station has the advantage of the boats, for the moves of the latter are met; they can no longer lurk in security close to a beam.

Where no high ground is available the beating off of attacks becomes much more difficult. The garrison approaches the conditions of a ship; and more guns are needed to make chance fire effective. There are, however, few harbors where, in one position or another, something could not be done after practical trial to improve the means of seeing and shooting at boats.

One great difficulty garrison gunners labor under is a want of knowledge of what they are exactly expected to do with regard to repelling torpedo-boat attacks in each individual fortress, and a want of authority, where they do know, for arranging their plans. The navy make their own schemes and often change them in accordance with their latest experience; defining areas into which they do not desire shore guns to shoot, arranging fresh boom defenses, detailing guard-boats, etc., while the artillery, perhaps quite unaware of this, continue their training and arrangements with a view to defending the whole water area. Naval plans when examined are generally found to be based on the conjectured presence of a considerable naval farce. If it could really be determined that there will always be a sufficient naval force at any given place the matter is extremely simple. Very few shore guns are then needed, and these being only to assist the navy, the latter should be made to define exactly the water areas which they require shore guns to defend. The navy, when in sufficient force, can best protect itself from torpedo-boat attack by keeping torpedo-destroyers, etc., at sea, booms, nets, etc. In this case it should only remain for garrison artillery to see that they have a reasonable quantity of suitable guns, mountings and electric lights, all rightly placed to carry out the task assigned to them. Even so they have trouble for, unfortunately for them, this is a business entirely removed from their control. Others place their guns and electric lights, frequently mounting both of them unsuitably for artillery purposes. It is a consequence of this nursing of garrison artillery that the chances of successful co-operation with the navy, in proportion to the money granted and expended, are often feeble. The nursing departments work, necessarily, on hard and fast rules, and have no elasticity for meeting unexpected local conditions or the wishes and needs of gunners. Unnecessarily elaborate magazines and emplacements are constructed which, once a gun is badly sited, fix it there permanently.

There are sea fortresses and coaling stations both at home and abroad as to which it would probably be very unsafe to count on the continued presence of a sufficient naval force locked up for local defense, whatever may be the scheme devised for that purpose by the navy in time of peace. Our navy is essentially an active, mobile power, capable of being applied anywhere, and it is incredible that circumstances may not arise to induce an admiral to take with him what he can lay his hands on for the purpose of striking a blow. It is frequently argued that if the admiral is out in front, as it were, of the base, the coast fortress is safe from serious attack. This, though perfect in theory and true, generally in fact has exceptions, and does not apply to light swift raids if the fortress is within striking distance of undestroyed hostile torpedo-boat stations. It is not only ships of war but all shipping which should be safe under British guns. Garrison artillery must often therefore not rely too confidently on any naval scheme, or rather must be prepared for its being thrown over, and must be ready to defend naval areas as well as those that are peculiarly their own. This raises a certain amount of difficulty. If there is a permanent fixed and defined area into which shore guns are never to fire, it is very easy to put up the danger guard I have devised for gun emplacements, so that neither light quick-firing nor heavy armament can, even by accident, shoot into it. This is necessary because one piece of water is exactly like another, and the 'naval area' boundaries are entirely imaginary. But if there is the slightest probability of the guns having to defend a larger area, two or more danger guards must be placed one behind the other and must be made removable to permit any one of them to be used at will. None must be permanently fixed.

Maneuvers seem to have clearly demonstrated one fact, viz.:

that until ingenuity is encouraged to devise a workable method of enabling shore gunners to distinguish friendly boats and launches moving about at night, from attacking boats, either the fortress guns are terribly crippled, or at the very least, made very uncertain in their action, or the friendly boats are sure to be hit. It is frequently stated that the navy have been so far unable to devise a plan whereby their ships can instantly and certainly recognize their own boats at night. Whether this is so or not the Gibraltar maneuvers have shown that, while the difficulty of distinguishing friend from foe, from a height not greater than a ship's tops may be insuperable, yet, where considerable heights are available, the case is not only far from hopeless, but promises to be fairly easy of solution, provided the shore guns are on a height and under the instantaneous control of a high station. This control can be readily obtained by the use of common electric bells at the guns, supplemented by the slower telephone. The signals from the boats must be continuous. Fairly frequent combined practice between boats and guns is, however, needed to make it at all safe for the former to be cruising about at night within range, and even then the anxieties of those in charge of the shore batteries, and of the lookouts, is vastly increased. When a considerable naval force is available, it may at times be advisable to limit the action of the shore guns to clear weather, when it is quite certain; making the defense in thick weather an active naval defense. The beautiful shooting of high, well mounted and well found, light Q. F. guns is, however, a means of defense which should never be lightly put on one side; the time may come when an overworked or temporarily crippled navy will be only too thankful for the rest which garrison artillery can assure them if permitted and encouraged to give it.

The average garrison artilleryman who has not had practice in resisting torpedo-boat attacks by night has generally a very wild notion of what these crafts are likely to attempt, what they look like, and what devices they may use to elude his vigilance. It is of the first importance that he should, if possible, be sent out in a torpedo boat during night maneuvers to watch what is done. One night spent in endeavoring to creep up unseen to within striking distance of their objective will go far to put him on his guard. It is exciting work at times, and once bitten with it he will always try to get out again. Until he has this experience his belief is frequently found to be that torpedo boats rush about at a twenty-knot speed, broadside on in the same way as he sees them dashing about when maneuvering in the day time. If an enemy will only act thus, and our lookouts are high enough, the discovery of his torpedo boats on many nights even without the aid of search lights, and always with them, is a simple matter. The wake of a rapidly moving torpedo boat gives her away directly, it is often seen hundreds of yards behind her and the eye running forward along the track comes on the boat itself. But, except for a final rush, if she finds herself discovered, this is not the way a cleverly handled boat conducts its business. Handled, as our navy do handle them, with infinite nerve and patience, moving dead slow, stoked with such ability that not a spark leaves the funnel, a torpedo boat is most difficult to detect and at any considerable range is often passed over unobserved by wandering rays. As the ray approaches she, perhaps, turns end on to it and stops; when, even if seen, she is often mistaken for a small fishing boat or something drifting, an error which even good lookouts are apt to fall into if a boat patiently waits without attempting to move, even though a round or two is fired at her. The best method of testing what a doubtful object may be is to take her range, bearing and speed (if it is thought unadvisable to waste much ammunition at extreme ranges) as quickly as possible and pass on with the light, to try and convey to the boat the impression that she has not been observed. Allow a few minutes to elapse and come back on her. If she has moved a considerable distance at a different rate in the interval, it is a torpedo boat, and it is as well to sink her; if she has not moved she is doing no harm, and the process can be repeated at intervals. Subsequent observation may show that she is creeping slowly up and it then becomes time to expend ammunition on her and make her either rush in or go out to sea again.

If undetected by a wandering beam and a torpedo boat desires to cross a fixed ray which she cannot get round by going far enough out, she either lies quietly just outside the fixed ray, in what has been termed by the lookouts the "dark ray," where she is quite invisible, and waits until a carbon needs changing to slip easily through, or else steams slowly up along the 'dark ray' until she gets as close as the land will allow her to the light, and seeks to destroy it with her fire so as to enable other boats to get to the ship which forms the objective of the attack. Various attempts are made to deceive. A torpedo boat may come up boldly with navigation lights boomed out to represent the lights of a friendly merchant vessel, for her own navigation lights are too close together to be mistaken. Such lights, however, are necessarily rather close to the surface of the water and the interval between them and their reflection is too small to deceive an expert for long, or prevent him examining her with the beam. If guns are low sited, boats may float smoke barrels with the tide across the slectric rays with a view of making them dim, but this has generally proved a failure from one cause or another. The presence of smoke in an unaccountable place only serves as a warning to guns to keep a brighter lookout. Smoke barrels do not seem to affect high-sited lookouts and guns at all. Every vessel approaching, no matter what may be known of her, must be carefully examined. No trick is more common than for a flotilla of torpedo boats to come up on the off side of a merchant vessel approaching a harbor with a view to a sudden rush if they can get close enough unobserved; in such a case a careful examination under the light will generally exhibit an abnormal lengthening of the vessel from time to time as one torpedo boat or another drops by chance a little behind. The vessel should be at once fired in front of and stopped.

Torpedo boats leave a remarkable and characteristic wake in anything like smooth water, said to be due to the waste lubricating oil pumped from their bilges. If in the early morning such streaks are seen it may be conjectured that boats have been in the neighborhood during the night.

Torpedo boats may disguise themselves in ways which it is perhape not best to suggest. A garrison artillery lookout-man must be astonished at nothing. Anything unusual or unaccountable must arouse his suspicion and be carefully watched for fresh developments ; indeed success in repelling the stealthy approach of torpedo boats is largely dependent on a trustworthy watch being kept. Experience, during long maneuvers, has shown that training is as necessary in this as in all other branches of coast defense, but the fact is but little recognized by garrison artillery, while the opportunities given them for practice are rare. At Gibraltar, where the peace lookout is in the hands of the Royal Engineers, on each occasion of maneuvers, the lookout-men had had, for the most part, no training ; men who had been present at former maneuvers and who had acquired some idea of what to look for, and what to report, were scarce, and for the most part lookouts were raw and often alarmed the detachments unnecessarily. Thus, for instance, a light house on the opposite coast, showing a green light, was over and over again reported as a suspicious craft, part, at anyrate of the detachments being unnecessarily roused ; while passing steamers, a long way out, and with manifestly no intention of coming within range, were continually being reported. It was seen that a considerable general knowledge of navigation lights and the "rules of the road at sea" is indispensable for officers, N. C. O's, and lookout-men. It is a direct proof of good training where it is seen that detachments not only turn out and do good work within a minute of being called up, but it is perhaps a stronger proof where the men are very seldom turned out at all. Such troops will never be worn out by a blockading fleet and will assuredly be smart when the opportunity really comes and the best of work is needed.

For guns intended for repelling torpedo boat raids, it is found essential that the detachments should live in shelters quite close to the guns, while, considering the somewhat dreary, prolonged, and generally fruitless watch that would have to be kept night after night, perhaps for months together in time of war, it is advisable that the men should be disturbed by false alarms as little as possible, being permitted to sleep or amuse themselves during the night as best they can, provided they turn out and are in action with extreme smartness on the whistle sounding. At the Gibraltar maneuvers the orders given for the lookout men were to the following effect:—

BY DAY.

On the best position for seeing the water area one lookout-man per battery is to be posted. He will keep a lookout all round and report at once anything he observes, as directed by the battery commander. Before quitting his post on relief he will point out anything under observation to his successor. (This day lookout was, of course, much of the nature of an ordinary sentry except that his arms and ammunition were near him only and his hands were free to use glasses).

BY NIGHT.

Six men will be detailed for each battery, say *A*, *B*, *C*, *D*, *E* and *F*. Each man will be on watch for two hours.

A will relieve the day lookout half an hour before sunset.
B will be posted one hour after *A*.
C " " " " " " *B* in relief of *A*.
D " " " " " " *C* " " " *B*.

and so on.

There was thus always one lookout who had been sometime at work and whose eyes were accustomed to the light, aspect of water area, etc.

Each of these men require binoculars. Those supplied during the Gibraltar maneuvers were excellent. They were of naval pattern, but were perhaps unnecessarily heavy.

Lookout-men at low sited batteries can see comparatively little, and in this case it may often be found better to keep one of the night lookout-men either in communication with the lookouts of the nearest high sited battery or send him to any higher place in the neighbourhood from which he can shout warning to the battery lookout-man. A portable, or permanent, telephone would, of course be much better, as the man could be sent to a more distant position. His shouts are apt to disturb the detachments unnecessarily.

Lookout-men must have it continually impressed on them not to allow their attention to become absorbed on a single boat. False attacks are purposely made to divert attention from the real and several real attacks may take place similtaneously. The system adopted at Gibraltar for lookout-men answered very satisfactorily when the lookout-men were reasonably clever. It prevented the men at the guns being worn out by long vigils; but many men displayed a lack of intelligence, or gave way to fancy, and in this event the N. C. O. or B. C. got too little rest. Probably sufficient reliable men could be found in each battery for lookout men, who in case of war should receive a small premium on truly reporting a hostile boat, with a deduction for false alarms. The untrustworthy men must be put to do the drudgery of the detachments, day lookout duty, etc. The efficiency of the defense so largely depends on good lookouts that every encouragement should be given to capable men. An ordinary sentry does not meet the case.

The vision of some of the men was found to be extraordinarily good at night and very correct. Such men should be noted, but it is impossible to pick them out without practice. Their ability in this respect seemed to have no connection with their ordinary avocation. Clerks from offices were sometimes as good as any. At the commencement of maneuvers the great majority do not know the appearance by night of what they are looking for; a torpedo boat in the moonlight, electric beam or in comparative darkness, seen from a high site is a very different object to what they know of it rushing about by day. It is difficult to impress on lookouts that a torpedo boat is most deadly and difficult for them to deal with when she is stealing about dead slow leaving no wake. In almost every case in which torpedo boats are made out without the aid of lights they are going at speed. Then their wake hundreds of yards behind them is first seen from a height and, followed by the eye, leads to the boat itself. Sometimes a spark flies from the funnel and catches a lookout's eye, almost unconsciously, directing his attention particularly to that part of the sea area where he eventually detects the boat, but even then it is generally the wash of the sea against the boat, or her wake, that he sees before he can satisfy himself as to the form of the boat itself.

On exactly the same principle that an offensive defense is very much more effective than a passive defense, a wandering electric beam is much more dreaded by attacking boats than a fixed beam, though the latter are what are mostly placed by the engineers for artillery use. When operations are really prolonged sufficiently to closely resemble actual war conditions, many points are brought to notice that escape the more limited experience of experimental committees. No doubt in one or two localities fixed beams have answered admirably, under specially skilled management. for an hour or two of experimental trial, with the result that they have been recommended for universal adoption; but in wearying prolonged trials, boats are found to easily slip through such fixed beams unobserved. It is a mere question of time. They lie patiently, even for half the night, until the light requires adjustment (it is a very cleverly managed light that does not require it frequently), and they are through in a few seconds—or, if the light is low sited they go out to sea a mile or two and pass through the blind angle caused by the curvature of the earth. In nine cases out of ten the belief inculcated in a fixed ray has greatly aided the boats; for if there is a wandering ray on the side of the fixed beam away from the boat, the light of the latter interferes with the wandering beam, while if the boat and wandering beam are on the same side of the fixed ray, the wandering beam has displayed a tendency in most hands, to leave the neighborhood of the fixed beam severely alone. Nothing would be so disconcerting to a boat commander as to find the fixed beam, under whose shelter he is comfortably waiting his chance, suddenly move on to him. He would have to go.

There may be, and probably are, localities, such as comparatively narrow channels across which an electric beam has complete power, where it may be thought distinctly advisable to keep a beam, capable of wandering, as a general rule steady on one bearing; but the power of motion and its judicious use is most valuable for gun defense. Boats will never effect much singly; moving beams are scarce, and there are no fighting lights, and thus the wandering beam is often occupied with a boat sent in purposely to show itself while the true attackers are dodging the rigidly fixed beam.

The one good thing with which a fixed beam may be credited, when conditions are favorable to its use, is the uncertainty it imposes on the attack. The carefully laid schemes of attacking boats are a good deal upset if they depend on a time basis. It is impossible to say when the light will break down, and if ordered to rendezvous at a certain hour inside the fixed beam for the purpose of a combined rush at a given hour it is probable that only one or two boats will have succeeded in reaching the rendezvous and some confusion may result. It is impossible to foresee everything and in such a case there is likely to be either hesitation or premature action, either of which may lead to failure.

If there are no good lookout-men the use of a fixed beam in a narrow channel may be an advantage. A lookout-man must be bad indeed if he does not detect a torpedo boat crossing a light at short range ; but a torpedo boat is very poorly handled if she runs into a fixed beam, except to draw attention off her consorts. She can always get through if she waits long enough.

A concentrated beam penetrates a much greater distance in nearly all states of the atmosphere than a dispersed beam, but it covers a comparatively small area of water. The dispersed beam gives a dim diffused light that often does not show up torpedo boats as a good target for guns unless the boats are fairly close in, while it is noticeable that guns rarely open fire so rapidly when a boat is first discovered in a dispersed beam as they do when a concentrated ray catches the craft. There seems more hesitation in deciding what is seen. Both with concentrated and dispersed beams the water just outside them appears extra dark, forming the ‘dark ray’ before mentioned. No matter what the state of the atmosphere or the appearance of the sea, boats are absolutely invisible in these dark patches.

The effect of site on the efficiency of electric lights in showing guns their prey does not appear to have received any consideration at all. Our latest experience shows that it is a matter of the greatest possible importance.

Suppose a battery B and two fixed lights $L\,1$, $L\,2$, all low sited. The battery B generally sees nothing of torpedo boats in the sea areas a, a, a, no matter how many wandering rays are showing them up, nor does B see them if the boats are at $al1$ or $al2$. The only chance the guns get of hitting is when the boats actually are crossing the rays or silhouetted in the water area b, b, b. If such batteries are working independently they get no warning and the boats are through in a few seconds. The above is a very

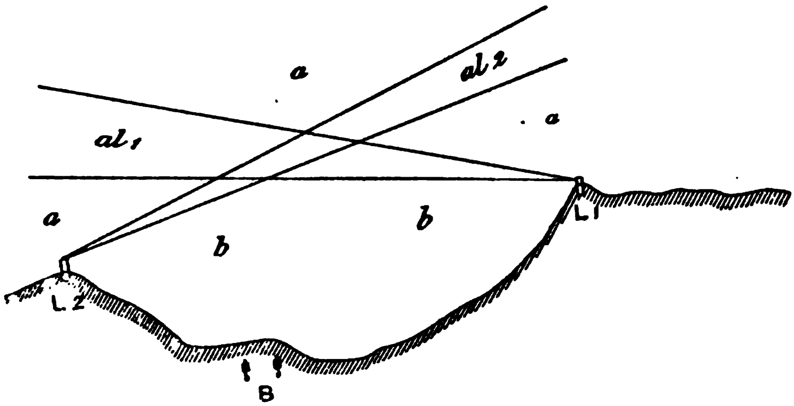


Fig. 3.

common form which electric installations for artillery purposes have taken. Those who have the selection of sites for electric lights can hardly have considered the question from the gun point of view, and until artillery are permitted to settle the sites both of their guns and of the electric lights, their hope of successfully keeping torpedo boats at a distance must be more or less forlorn, no matter how large the armament. A small, well sited and well formed armament with electric lights under the same management could dispose of torpedo boats with far greater certainty and economy than five times the number of guns and lights badly placed and opposed to each other. It seems incredible that such an adjunct to gun fire as electric light should be treated as a thing entirely apart from garrison artillery, yet such is the fact!

It is to be hoped that if the chance ever falls in the way of an artilleryman of arranging guns and lights for his defense he will not content himself with the consultation of plans, contours, charts, etc., the fruitful cause of faulty work up to the present, but that he will settle the question on the ground itself by actual trial, the only method affording hope of success. The trial need not be a costly affair, but it must be somewhat prolonged as it must embrace variation of weather. It would repay its expenses and the trouble given to it ten times over in the avoidance of costly and constant changes afterwards. The means required are a dozen or so observers, a torpedo boat or launch, two portable electric lights, several D. R. F. instruments on tripods, and a few Verey's pistols with cartridges, the D. R. F.'s and Verey's pistols would represent the guns.

The maneuvers have very clearly demonstrated that the effective lighting of water areas is not so much a question of brilliancy of ray as of selection of site for the installation and that in siting lights near the sea level the engineers are in error.

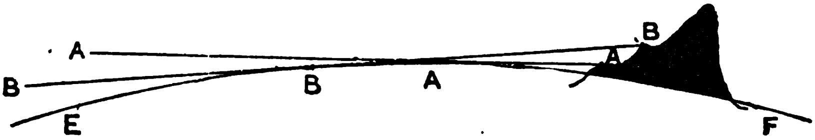


Fig. 4.

If $E\ F$ is the curve of the earth and there is a light at A throwing a ray $A\ A'\ A''$ there is a dark portion between E and A' which affords a shelter to boats. If now the installation be moved to B the range of the light is vastly increased and there is practically no dark space, except possibly close in shore, where generally no light is needed, or if it is, can be supplied by a weak instalment flanking the shore, or by temporarily depressing B.

The writer has never had an opportunity of using an electric light installed at a greater height than of about 80 feet, and that a weak portable one, but even at this height it appeared to be more effective for gun work than far more brilliant lights lower down. A high installation has not to drive its light through so many layers of dense atmosphere and smoke and it has a much larger target to light up. Trial might show that the higher a light is placed the better.

But another fact was frequently recorded during maneuvers where low sited lights were used which does not seem to have been noticed before and which is much in favour of torpedo boats.

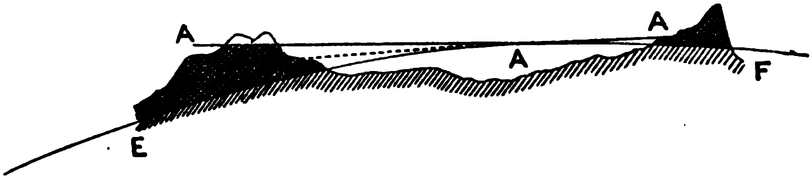


Fig. 5.

The rays were seen to be deflected upwards increasing the dark area $E\ A'\ A''$. Where one light was a few feet higher than the other, it was thought that this deflection was not as great in the case of the higher light as with the lower. This needs further experiment and confirmation. Some mountains, seven miles or so away and 2000 feet high had their tops brilliantly lit up by a very powerful low sited light, the greater part of their mass being in shadow, yet the light was being employed to show the surface of the water not 1000 yards away.

It is evident that the knowledge of siting electric lights on shore is in its infancy, and until garrison artillery, who really need it for practical purposes are given facilities for taking up the question, it is not likely to grow fast. The navy, who have constant practice, have learned to site their lights as high as they can be conveniently worked. There are few fortresses in which they cannot be placed higher than on board ship.

Fighting lights, very high sited and at the command of a superintending officer, would add enormously to the power of the guns relieving the wandering beams of the custody of any boat that they found and permitting it to search for others. It is somewhat doubtful if fighting lights would confer much advantage if no high ground is available for either guns or lights, for they would then be liable to blind some of the guns, but repeated trial during maneuvers would discover some sites where they could be used with advantage to the defense.

Very often parachute fire-balls, or something of that nature, would be extremely useful to give a general view over water areas, but here again a difficulty for garrison artillery crops up. Laboratories are no longer at their command and unfortunately 'fire-working' is no longer a part of their training, so that the adaptation of artillery materiel to fighting requirements as they arise is practically impossible. The genius of modern garrison artillery finds its grave in requisitions on departments. Even the well tried and clever inventions of past artillerymen are being lost to modern use; they are unattainable if not in some store schedule.

[*Proceedings of the Royal Artillery Institution*, January 1899.]

PROFESSIONAL NOTES.

ARTILLERY MATERIAL.

New Type Wire Guns.

We have frequently spoken of the wire or riband guns now in the service, and have given various data connected with them. The Royal Gun Factory has recently brought out an addendum to the Service Treatise on Ordnance, in which the most important matters dealt with are the descriptions and drawings of the service wire guns and our new howitzers. As most of our readers are aware, the use of wire furnishes a gun of a given weight with so much additional strength that much more energy can be obtained from it. For example, the gun can be made with thinner walls and increased length. Thus the 12-inch guns of ordinary construction, known as "Marks I. to VII." were 328.5-inches long, and delivered their projectiles, which weigh 850 pounds, at the muzzle with 1915 foot-seconds velocity, or 18,139 foot-tons energy. The wire 12-inch gun, Mark VIII., is 445.5-inches long, and delivers its 850-pound projectile with 2367 foot-seconds velocity, and about 33,020 foot-tons energy. There is a new 12-inch gun, Mark IX, which will, it is hoped, have something like 2600 foot-seconds velocity, and 39,850 foot-tons energy, but it is premature to give definite figures. It will be seen, then, that the increase in power in the 12-inch wire gun is very great. It is no doubt true that some foreign guns, which are not of wire construction, claim equally high velocities, but we have satisfied ourselves that where this is achieved, it is done at much greater risk to an ordinary piece than to a wire gun. Moreover, it may be noticed in foreign tables that the high velocities shown are at times only calculated, and fail to be realized, at all events as service velocities; so that, after a while, a lower velocity is substituted for that at first put forward.

Apart from the adoption of the wire system, changes have been made in the breach action, which is now worked by a single motion. It is desirable to make this clear, because our heavy pieces are probably served with the same speed and ease as some foreign guns which are designated quick-firing pieces. Statements of British armaments are further likely to be misunderstood, owing to the fact that, having dispensed with the metal cartridge in our new 6-inch gun, it is proposed not to call this a quick-firing piece, in order to make it clear that it does not take the usual quick-fire metal cartridge. From the point of view of a store ledger this may be convenient, but it can hardly fail to cause general misunderstanding, and it seems desirable that some designation should be adopted which points to the gun being a very new and efficient quick-fire weapon, and not an obsolete one.

To return to the 12-inch gun, Mark VIII. Fig. 1 is from the official photograph showing the construction of the piece. The principal features to notice are the application of the wire, the length of the bore, and the form of chamber. The piece is, as may be seen, trunnionless. The principal dimensions and data are as follows: Length, 445 5-inches; caliber, 12 inches; length of bore, 425.15-inches, or 35.429 calibers; chamber diameter, maximum 16 inches, minimum 12.8 inches. The rifling is the so-called polygrove, modified plain section, with a twist increasing from 0 to 1 in 30 calibers at the muzzle. The weight is 46 tons, that of previous pattern being 45 or 47 tons. The gun has a steel "A tube" extending from seat of obturator to muzzle. The inner A tube is secured longitudinally to the A tube proper by means of corresponding shoulders, and a steel breech bush is screwed into the A tube at the rear end, the breech bush being prepared for the reception of a breech screw. Around the A tube are wound successive layers of flat steel wire, extending from the rear end of the chamber to within a few inches of the muzzle, the ends of the wire being secured to steel rings provided for the purpose. A steel ring forming a stop for the wire is shrunk on to the A tube at the breech end. Over the wire come jacket and B tube, being secured by shoulders, etc. The C hoop is screwed over the jacket, and is prevented from turning when in position by means of a steel pin, which is passed through the C hoop into the jacket, and secured by a screwed rivet. "Thrust rings" are formed on the exterior of the C hoop and jacket, to secure the gun to its mounting. Guns are designated "right" or "left" according to the place they are intended to occupy, and are fitted with the mechanism required to work them from each side, when mounted as a pair in turret or barbette. The breech screw has a thread with six interruptions, and is therefore locked by one-twelfth of a turn.

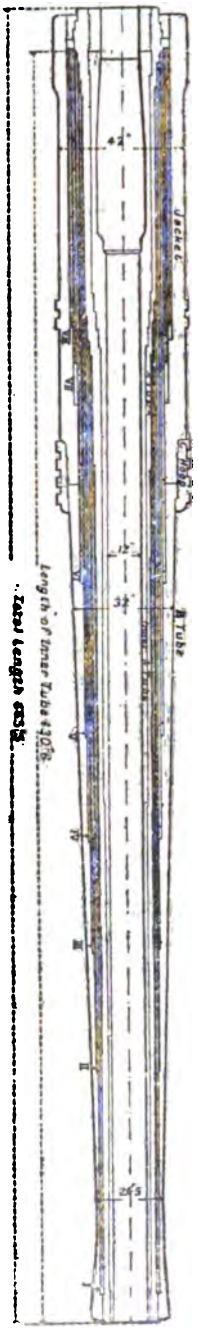


Fig. 1. 12-inch Mark VIII wire wound gun.

Fig. 3 shows the breech mechanism from the rear and in vertical section. The right side of the screw is secured to receive a steel rack by which it is pushed into or withdrawn from the gun. The last two teeth from the rear end of this rack are made much stronger than the rest, and of different shape, to give the increased strength required for the last part of the movement in inserting the breech screw. The rear end of the rack itself, and a portion of the screw over the rack recess, are cut away to give the necessary clearance for the working of a flange on the rack pinion. Attached to the rear face of the breech screw by fixing screws is a bronze end plate—A in Fig. 2—on the bottom of which is formed a handle for withdrawing purposes, and on the top a recess, usually filled by a preserving block, for the attachment of a cam lever for use when the usual working fails. On the right side of the end plate, fitting in an under cut, and held by a fixing screw, is a steel plate E, the inner face of which is cut away, so as to form an eccentric groove termed the roller path, on the side of which the friction roller of a crank acts in turning the breech screw. On the same side of the end plate, but lower down, is a steel roller F, with axis pin and set screw, which, in conjunction with a flange on the rack pinion, serves to start the obturator and screw from its seating. The axial vent and obturator are of ordinary form. The vent, fitted with spring washer and nut, and prepared for the reception of a shell box, has, owing to the recessing of the breech screw, a much shorter spindle than usual.

Fig 2

12·INCH B L MARK VIII MECHANISM.

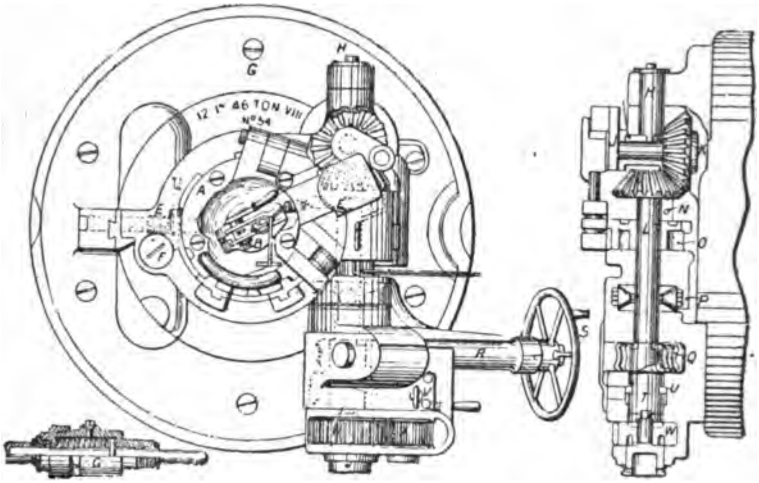


Fig. 3

ORDNANCE, B L. 9·2 INCH, WIRE. MARK VIII (N) 25·TON.

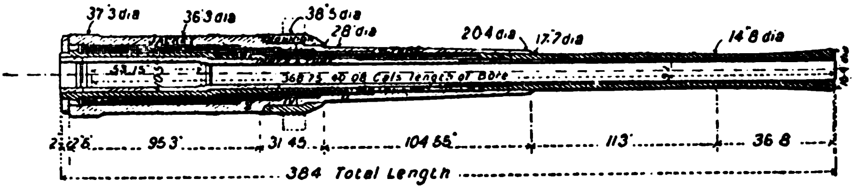
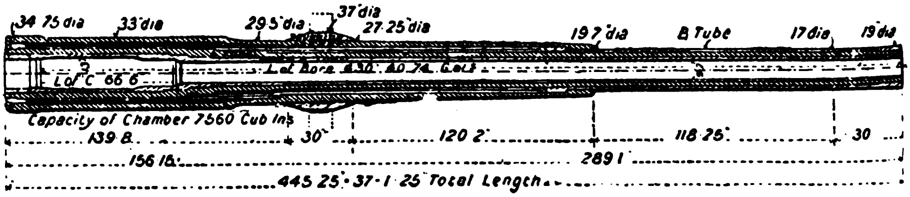


Fig. 4.

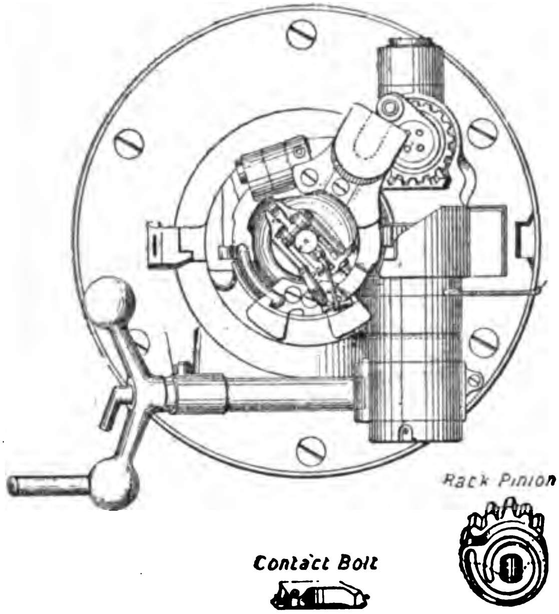
ORDNANCE, B. L. 9·2 INCH, WIRE, MARK IX (L) 27·TON.



A circular plate of bronze C, termed the "frame breech mechanism," is attached to the face of the breech by six fixing screws. On the left side it is cut away to conform to the shape of the breech, and it has a projection C^1 recessed to receive the outer end of the "clip retaining," during the pushing in or withdrawal of the breech screw. G is the piston of the buffer; D, ring carrier of bronze, with projections D^1 D^1, formed to give the required bearing for the breech screw when withdrawn; E, small steel friction roller; F, screwed recess for attachment of G, buffer; H, upper portion of hinge bolt; I, gun-metal bush; J, friction roller; K, bevel wheel; L, lower portion of hinge bolt; M, wheel bevel; N, steel contact bolt; O, steel rack pinion; P, metal roller frame; Q, bronze worm wheel; R, frame bearings; S, handle; T, clutch; U, forked lever clutch; V, guide bolt; W, clutch pinion; X, automatic pinion.

Fig. 5.

9·2·IN. B L. MARK VIII



9·2in. BREECH MECHANISM

To open breech it is only necessary to turn the worm spindle by hand wheel S, which, by its bevel wheel gearing, first turns the breech screw round into the withdrawal position, and then forces it back until firmly held by the carrier, and finally swings the breech screw and carrier together round to their loading position, that is, clear of the bore, the gear being devised to carry this through with one continued movement of the hand wheel.

To close the breech, reverse the hand wheel, thus first swinging round the carrier with the breech screw on it, the latter being brought truly opposite to the bore; then the rack and pinion coming into action, carry the screw home into the breech, and the crank turns the screw round till it is locked, this being accomplished by one continuous turning motion of the hand wheel.

In some ships provision is made for automatic working by recoil, but a hydraulic arrangement has been substituted in later mountings. In the event of the ordinary gear being put out of order the mechanism can be adapted for working by hand.

Figs. 3 and 4 show the 9.2-inch breech-loading wire guns, "Marks VIII. and IX." These pieces correspond to the gun before described; that is to say, they are wire guns of greatly increased power. Their weight, however, is greater than that of their predecessor, Mark VIII., weighing, 25 tons and Mark IX., 27 tons; whereas the heaviest previous pattern, Mark III., weighed only 24 tons. Mark VIII. has a muzzle velocity of 2347 foot-seconds and 14,520 foot-tons energy. Mark IX. is intended to have 2700 foot-seconds velocity and 19,220 foot-tons energy, the weight of projectile for each being 380 pounds. —*The Engineer*, February 24, 1899.

War Material.

The most important questions in war material are those which have arisen owing to the illustrations afforded by the Spanish-American War. Simple as most of the lessons enforced are, they have made their mark on the warships of all nations in a greater or less degree. The fact is that the probable effects of various features may be seen and anticipated in time of peace without at all appreciating the proportions which each may assume in actual war. Thus, we may be aware of the destructive nature of shell fire on the one hand and of the fatal effect of successful torpedo attack on the other, but experience in actual war is needed to teach us the chances of one or the other coming into play, and forming the dominant factor. The Resistance and Belliqueuse experiments had certainly shown the terrible effects of shell fire on ships, yet they were not fully appreciated, we think, either in England or France. Curiously enough, Germany, who did not conduct trials on actual ships, so far as we know, seems to have profited in one respect most by them. To come, however, to the lessons of the war. The main facts of the Santiago engagement were that four Spanish armored cruisers, appearing—on paper—to be of an unusually formidable character, attempted to escape from the harbor of Santiago, running the gauntlet of the fire of the United States fleet outside. Three of these, the *Maria Teresa*, *Viscaya* and *Oquendo*, had very strong complete belts, but unarmored upper structures. The fourth, the *Christobal Colon*, had her upper structure covered with 6-inch Harveyed armor, and was provided with a powerful battery of quick-fire 6-inch guns. Had the United States vessels been caught, as might have been hoped, not quite ready, the whole of the Spanish cruisers ought to have escaped, for their nominal speed was considerably above that of the American battleships, and even the two American cruisers might be unable to get up full speed in time to overhaul them. When the Spaniards came out and ran westward, the *New York* cruiser happened to be away, and the *Brooklyn* was at the west of the harbo mouth, so that it might be hoped that the Spanish ships in passing her might all deliver their fire, and thus cripple the only ship capable of overhauling them. The American battleships, however, were so completely ready that the Spanish funnel smoke was perceived, and the few minutes available sufficed to enable the Americans to close in and deliver their fire so effectually as the Spaniards emerged that the hulls of the *Maria Teresa*, *Vizcaya and Oquendo* were riddled and set on fire, and they were run on shore and captured, while two torpedo catchers who tried to escape with them were destroyed. The *Colon*, however, suffered no injury, and obtained a lead of fou

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miles, when her speed failed, and the *Brooklyn* and *Oregon* battleship came up with her and attacked her, and she then at once surrendered. It is easy to see from the above that a belt is useless if a ship's upper structure can be utterly destroyed in a few minutes. The natural steps to take, then, are to armor the upper structure even at the expense of the belt. The *Colon*, had her speed not broken down, would not only have escaped, but escaped practically without injury; hence the value of her 6-inch Harveyed armor. Further, all wood should clearly be got rid of at any cost. Our own armored ships are already well constructed to bear fire on their upper structure, the armor being generally continued from the belt upwards, but we must get rid of wood, especially in parts where no armor exists. The Germans have already got rid of wood. The French, with their heavy complete belts and consequent weak places for lack of armor above, seem to be in the worst condition. Even with battleships, metal is coming off the belt. The newest Russian design for the battleship being built at Cramp's yard has the 9-inch belt supported by the armored curved deck of our *Majestic* class; in fact, Sir W. White claims to be the designer in a great measure of the newest types of battleships of most naval powers, France at present being the principal exception. We have spoken of both cruisers and battleships, for the principle applies to both. Had the *Brooklyn* alone come up with the *Colon* she ought to have found herself awkwardly placed, for only her 8-inch guns had a chance of piercing the *Colon's* 6-inch plates even with shot, while the *Colon's* 6-inch quick-firing guns and other pieces ought with shell to have riddled and destroyed the *Brooklyn* very quickly.

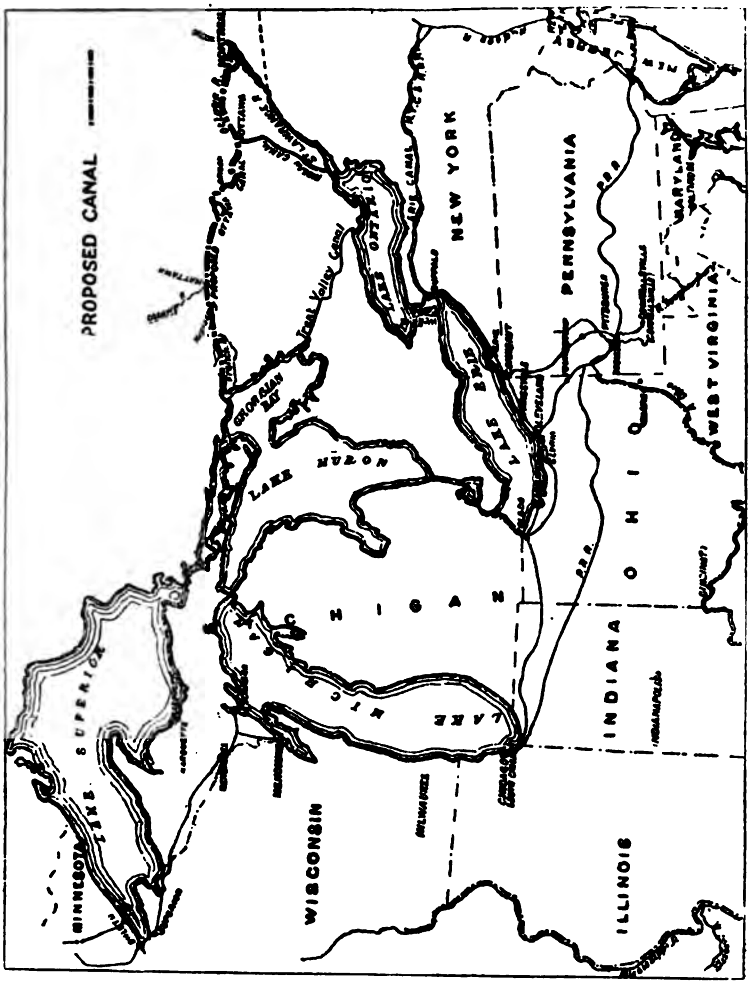
As to quality of armor, the principal progress has been in the introduction of the Krupp process plate, which combines with the hard face of the Harvey very great toughness, so that it possesses both the power to defeat the boring attack of sharp-pointed projectiles by breaking their points, and also increased resistance to punching and tearing. Consequently, during the past year Krupp process armor has not only come in completely in England, but has been adopted in the United States—the home of the Harvey process. Before leaving this, we are glad to notice the progress of Hadfield in armor-piercing projectiles, and of Beardmore in devising a new and excellent kind of hard-faced armor, and both these are British conceptions. In ordnance, progress has continued on the same lines as last year, that is to say, quick-fire has been further developed, and new long guns, firing smokeless powder with high velocity, have come in. In this country the remarkable Vickers 6-inch quick-fire piece, tried last winter, has been adopted, and a quick-fire gun of larger caliber, 7.5-inch, it is said is coming in. The former is simply a more powerful and efficient substitute for the 6-inch quick-fire gun which has long been the broadside gun of our most powerful battleships and cruisers. While possessing more power, the new piece has a great advantage in the Weling breech action, which both offers advantages in strength and quick working, and also enables a metal cartridge to be dispensed with. The very high muzzle velocity attained by this and other new guns seems to be lost quickly, for which remedies are sought in special forms of gas checks and in alternative forms of powder. Cordite has shown grand service qualities, but its erosion is very great, and possibly greater than that of some other smokeless powders, of which Russia claims to have a peculiarly successful kind; but thorough trial is necessary to establish the merits of any powder. Although smokeless powder has been in use for nine or ten years, America, with all her enterprise in most questions of war material, was found without it in the last war, and her ships must have felt the evil in attacking the Spanish cruisers. In pursuit, the escaping vessel would benefit by smoke which she would constantly spread between herself and her pursuer, while the latter should undoubtedly have smokeless powder. Contradictory statements have come to us, but, as far as we can learn, only one Spanish ship, the *Colon*, had smokeless powder, so that in her chase the conditions were wrong in each case, for the escaping ship had smokeless and the pursuers smoke-giving powder. It need hardly be added that since the war, America has decided to adopt the former, and at the same time to arm her vessels with powerful quick-fire guns. Our readers may some of them remember that her feeble quick-firing batteries were a constant source of wonder to us, especially the ridiculous 4-inch pieces of the *New York*. America will now mount 8-inch quick-fire pieces. With the conviction that the upper structures of most warships will carry 6-inch Krupp armor before many years are past, we could wish that England would also adopt 8-inch quick-fire guns. As to heavy guns, our new powerful pieces are the Vickers 12-inch and the 9.2-inch, each known as mark IX. The former has even greater penetration than the 111-ton 16.25-inch gun, and is likely to be the heaviest piece carried by our men-of-war for a long time to come. It is not probable that these powerful pieces can be dispensed with, because while the broadside or secondary batteries of quick-fire pieces had it all their own way in the late war, the *Colon* furnishes an example of a vessel which would defy such attack successfully. With two such ships, an engagement might continue sufficiently long and be sufficiently hard fought to come to be decided by the effect of the attack of the heavy guns, whether delivered against the primary or secondary parts of the enemy. One great difficulty we have overcome this year. We have found means to carry and fire with safety shells charged with high explosive, so that shells charged with Lyddite are now issued for service.

As to light guns, quick-fire is now coming into the field artillery of the leading powers. So long as the recoil of a field piece so far disturbed its aim that relaying was necessary after each discharge, quick-firing guns could only offer the advantage due to quick loading, and if the piece was kept waiting long by the laying, any gain in quick loading seemed more than counterbalanced by the evil of carrying metal cartridges containing their own ignition. At last, however, the De Bange obturator has been found sufficient, and the metal case may thus be dispensed with; also great advance has been made in checking and controlling the recoil of the piece. We have from time to time spoken of spades fixed on the trail, which recoil drives into the ground. One French design of this kind was exhibited at Chicago in 1893. Subsequently we gave illustrations of an Elswick field-carriage, in which the spade was fixed by a shaft to the axle-tree, which was a great improvement, because the carriage naturally pivoted on it in a sense, and the trail was easily brought into line; whereas if the trail is the fixed point, not only does the gun jump more, but to line it it is necessary to do something like cross-lifting the carriage. We have a work of Krupp's showing designs in which spades are fixed to axletree, trunnions and trail. Sir George Clark has a very neat design of an improved carriage, with a very strong spade action connected with and pivoting on the axletree, and strengthened by suitable connection with the trail. Probably quick-fire will have come in before any army takes the field again, in which case the supply of ammunition will become a problem of grave dimensions. —*The Engineer*, January 6, 1899.

MILITARY GEOGRAPHY.

A Great Canadian Canal Scheme.

The scheme for the construction of a ship canal to connect the St. Lawrence River with the great lakes which lie between Canada and the United States of America is again revived, and has, as champion, Mr. McLeod Stewart, the son of the member of the Legislature Chamber of Ottawa, who brought the question forward as far back as 1847. The result of such a ship canal would be that the steamers carrying the grain from the great plains of the northwest would be able to steam right through to the Atlantic during the season, whereas at present the cargo has to be transhipped twice in the journey, involving very considerable expenditure. The advantages of such a scheme have long been recognized alike by the States and the Canadian people; the difficulty is to settle upon the best route. Americans, of course, prefer that the outlet into the Atlantic should be New York, and the Erie



Canal and Hudson River has long been regarded by them as the only feasible route.* But the Canadian scheme, apart altogether from Imperial considerations, offers superior advantages in respect of distance traversed from the ports of Lake Superior and Lake Michigan; and, moreover, the configuration of the country between Georgian Bay and Montreal suggests that the construction would not be costly. The fact that the route is the natural one is, in a manner, supported by the circumstances that it was along it that the first European—Samuel Champlain—found his way in 1615 to the great island seas of the Continent; and for many years subsequently it formed the principal channel for carrying on the business of the Hudson Bay Company, whose lines of forts, or trading stations, were distributed along its whole extent. It is the route taken by the Canadian Pacific Railway, and as one writer has put it, "it is more nearly an air line than any other stretch of inland navigation which can be found in all the world."

A glance at the map will show that Lakes Superior, Michigan and Huron resemble the three Legs of Man, with the Sault Ste. Marie Canal as a center; Lake Superior extends away to the northwest, Michigan to the south, and Lake Huron to the southwest, with the Georgian Bay lying in the northeast corner of the latter, directly in line with the Sault Ste. Marie Canal, so that the Bay is the nearest point of outlet from all three lakes to the sea. The traffic through the Sault Ste. Marie Canal affords an indication of the great traffic on the lakes, and much of the freight is for Europe. Thus, 13,500 steamers, or nearly 19,000 of all craft, pass through the canal in a year, the registered tonnage being between 17 and 18 million tons, and these carry over 16 million tons of freight, including 65 million bushels of wheat, and 27½ million bushels of other grains.

The distance between Georgian Bay and Montreal, the port on the St. Lawrence River—almost a straight line through a valley, with lakes and rivers, rapids and waterfalls—is 430 miles, but only about one-eighth of this requires to be canalised. The length of the whole route, say from Chicago to Liverpool, is 3780 miles, whilst by way of Buffalo, the Erie Canal and Hudson River to New York, and thence to Liverpool the distance is 4495 miles, or via the Welland and St. Lawrence canals and river, 4148 miles. Moreover, in the first case the length of lake and restricted navigation is 980 miles, against 1415 miles via New York and 1348 miles via the Welland and St. Lawrence canals and river, so that there is not only a saving in distance, but there would also be a probable economy in time occupied in transit.

We have indicated that the route is a natural and easy one, and a brief glance at the results of surveys will show this. As early as 1856 a Government survey was made. It was reported then that the canal work would be 58 miles long, and to give a draught of 10 feet would involve an expenditure of five million sterling, while three years later a second survey was made, and in this case it was thought 20 miles of canal would suffice by damming the Ottawa and the Mattawa rivers to a greater extent than was proposed in the first instance, and the cost was put at about 2½ millions for 12 feet of depth. The reason why the matter was then dropped is to be found in the troubled times experienced—the financial crisis of 1857-9, the American Civil War, frequent Government changes and the federation scheme. Since then a sympathetic interest has been taken in the work, but without practical issue. Early in the seventies there was a vigorous movement in favor of canals, and several schemes were helped forward, but the project of which we are now writing has not got beyond the prospecting stage.

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* See *Engineering*, vol. lxv, page 309.

The proposed route, according to Mr. Marcus Smith, M. Inst. C. E., may have been the main channel of outlet from the lakes we have already named, to the St. Lawrence, the barrier being really the result of an upheaval. Starting from Georgian Bay there is first the French River, and at the outlet into the bay the height is 572 feet above sea level. It has a well protected and capacious harbor, while 25 miles up the river there is another harbor 5 miles long, selected by the Canadian Pacific Railway for their Georgian Bay terminus. The river really consists of a series of small lakes connected by falls, the source of supply, Lake Nipissing, being 632 feet above sea level. The lake is nearly 50 miles distant eastwards from the bay, and in that length there are eight falls, one of 7 feet, and another, at the lake, of 26 feet; the total ascent is about 60 feet. Lake Nipissing is about 40 miles in length, and of great depth, with several islands. Four or five miles further on—up the River Ojibwaysippi—is Trout Lake, 8½ miles long. This is at the summit, 655 feet above sea level. The total height to be overcome from the lakes would, therefore, be about 83 feet. The proposal is to raise Lake Nipissing 5 feet, and to lower Trout Lake, which has great depth. This lowering by 18 feet would necessitate four or five miles of cutting, the maximum depth being 30 feet; but for the most part it would be about 12 feet, probably through crystalline rock. This would reduce the number of locks to about eight, one of which, into Lake Nipissing, would be about 32 feet high, and operated by hydraulic power. There would be eight other locks in this length of 85 miles, and several dams for the river. Immediately beyond Trout Lake, separated by a rocky bar 400 feet in length, is Turtle Lake, 4¼ miles long, and only one foot lower than Trout Lake, with detached shoals due to needles of rock, rising to within 8 feet of the surface. The outlet is through a rocky river four miles long, and it falls 32 feet into Lake Talon, seven miles long. Turtle Lake, however, would be lowered, as well as Trout Lake, and Talon Lake raised to the same water level, so that all four lakes from Nipissing would be one continuous length of fully 55 miles, with an adequate supply of water from the last-named lake. This would necessitate some extensive rock-cutting and banking, but it would obviate a large number of locks, which would be a permanent disadvantage. Thus rather more than the first 100 miles of the route of 430 miles are accounted for.

For the next 16 miles or so there are a number of falls with Lake Aiquilles and Lake Chant, necessitating some 11 locks, and then the confluence of the Mattawa and Ottawa rivers is reached. For 190 miles down to Ottawa the latter waterway is a broad and deep river with a gentle current broken at intervals by rapids or falls and anon expanding into broad still water stretches and lakes. At the confluence the height is 485 feet above sea level, while Ottawa harbor is 114 feet, but the fall is very considerable within some short distances. Thus at one point it is 32 feet in three miles, in other cases 45 feet in two miles, 28 feet in two miles, 93 feet in five miles, 50 feet in three miles, and 67 feet in four miles; so that in this stretch of 190 miles it is not expected that there would be more than 22 to 25 miles of canalization, although some of the locks would be of considerable height. The distance from Ottawa to Montreal is from 110 miles to 116 miles, the fall being about 104 feet, 44 feet of which is at the St. Louis rapids, and about 54 feet within the 12 miles between Grenville and Carillon. Thus, of the total distance from Georgian Bay to the St. Lawrence—430 miles—only about 58 miles or so has to be canalized, and the rise by lowering the summit lakes as suggested would be 83 feet from the bay, and 624 feet from Montreal.

—*Engineering*, February 3, 1899.

The Railways of Hokkaido, Japan.

Hokkaido, or the Island of Yesso, lies to the north of the main island of Japan and has an area of 30,000 square miles, not including the Kurile Islands. The area suitable for cultivation is estimated at 7,000,000 acres, and it will accommodate a population of 5,000,000, when peopled with the same density as the northern part of the main island. The present population is 800,000, with a rate of annual increase of 8%, and about 400,000 acres of land are under cultivation. The annual product of the fisheries is about 150,000 tons. The extensive coal beds now supply about 500,000 tons annually, and there is a considerable production of precious metals. The climate of the island ranges from 0° F. in winter to 90° F. in summer, but in some parts the temperature reaches as low a point as —30° F. in winter. The depth of snow is about 2 feet in the east, 3 feet to 4 feet in the west and from 4 feet to 5 feet in the center of the island. In some localities the snow fall reaches the exceptional depth of 8 feet to 10 feet. The sea is smooth in summer, but in winter it is rather rough. It does not freeze except along the northeast coast, where, from December to March, drift ice is met with from Cape Soya to Cape Noshapu. This ice has its origin in the northern part of the sea of Okhotsk, and it packs along the shore for a width of from 10 to 20 miles and completely stops all traffic by sea. Other parts of the coast are always navigable.

The first railway in Hokkaido was constructed in 1880 for transporting coal from Poronai to Otaru Harbor, a distance of 55 miles. In 1891 the line was extended to Sorachi, Yubari and Murorn, making a total of 205 miles of railway. This railway is now owned by the Hokkaido Coal & Railway Co., and has a traffic of 60,000,000 ton miles of freight, including coal, and 1,600,000 passengers each year. The location of the line is shown by the map, Fig. 1, which is reproduced from the official map of the Hokkaido Government Railways.

In 1896 the Colonization Railway Act was passed by the Japanese Congress, and work was begun on 600 miles of new line to be completed in twelve years. These lines were as follows:

	Miles.	
Section.	Length.	Completed, '98.
1. Sorachibuto—Asahigawa	36	36
2. Asahigawa—Soya	180	24*
3. Asahigawa—Akkeshi	227	36*
4. Akkeshi—Abashiri	90	Not commenced.
5. Akkeshi--Nemuro	65	"
Total	598	96

The following is a short physical description of each of these lines:

1. Sorachibuto-Asahigawa, 36 miles. For 23 miles from Sorachibuto (80 feet above sea) the line passes through a flat, fertile plain, with two river crossings, and its longest tangent is 11 miles. From mile 23 to mile 30 the line winds along the steep right-hand bank of the Ishikari River (Kamoikotan as it is called) with numerous curves and two short tunnels. From mile 30 to Asahigawa (330 feet above sea) the line passes through the flat, fertile plain

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*From Asahigawa.

of Kamikawa. At Asahigawa the line divides, one branch going to Soya and the other to Akkeshi.

2. Asahigawa-Soya, 180 miles. At 18 miles north of Asahigawa, the line crosses a ridge having an elevation of 800 feet above sea. Then gradually descends along the Teshiwo River until it reaches Soya. This line passes through the Teshiwo coal fields.

3. Asahigawa-Akkeshi, 227 miles. For about 70 miles from Asahigawa the line passes through a comparatively flat district. It then crosses a ridge of 2,000 feet above sea level, and several thousand feet of tunnelling is required there. This mountain section extends about 20 miles when the line again comes to the very flat, fertile district of Tokachi. At 200 miles from Asahigawa it reaches the harbor of Kushiro. From Kushiro to Akkeshi, a distance of 27 miles, it passes through the Kushiro coal field, which is rather hilly, and requires several short tunnels.

4. Akkeshi-Abashiri, 90 miles. At about two-thirds of the distance from Akkeshi there is a ridge whose height is 900 feet above the sea. One or two thousand feet of tunnelling is required in the few miles crossing this ridge. The rest of the line is comparatively flat. The sulphur mine of Kushiro is situated near the ridge.

5. Akkeshi-Nemuro line, 65 miles long, is through flat districts.

The gage of these lines is 3 feet 6 inches, and flat-bottomed steel rails, weighing 45 pounds yer yard are laid on wooden sleepers. Thirteen sleepers are used for a 30-foot rail. The maximum grade is 1 in 40, and the minimum radius of curvature is 8 chains. The island of Yesso is rich with timber, and the materials imported are rails, wheels and axles, locomotives and machinery. The locomotives are mostly of the Mogul type and weigh from 24 to 50 tons. They are used for mixed service. Passenger cars are generally of the bogie type, 53 feet in length and 8 feet wide, with 33-inch wheels and 5 feet 6 inches wheel base. Freight cars are also mostly of bogie type, 27 feet in length and 8 feet wide, with 24-inch wheels and 4 feet wheel base. Automatic couplers of the M. C. B. type, with the center placed 24 inches above the rail level, are to be adopted. All passenger cars have end doors and are heated by stoves.

The principal workshops are at Asahigawa and at Kushiro, with smaller repair shops at Soya, Abashiri, Nemuro, etc.

By S. TANABE, M. E.*

—*Engineering News*, February 23, 1899.

The Inter-Oceanic Canal.

A direct outcome of the recent American-Spanish war is the contemplated construction of a canal across the isthmus separating the Atlantic and Pacific Oceans. That this waterway, several times ineffectually constructed by the United States cannot be doubted. The voyage of the *Oregon*, although a splendid triumph for American engineers and shipbuilders, would, in the face of a more active and calculating foe than Spain, have probably ended in disaster.

America recognises that her fleet must be available in either ocean as may be required, and that trade facilities must be made. President McKinley voiced public opinion in America recently when in his Message he stated:— "The construction (of an inter-oceanic canal through Nicaragua) is now more than ever indispensible, and our policy more imperatively than ever calls for its control by this country. I do not doubt that Congress appreciates this."

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To England, as the greatest maritime power, the building of this canal must prove of vast importance. She needs every waterway that can be opened for her, both in peace and in war. Reference to the Suez Canal is unnecessary in support of such axioms of England's welfare, but it may be pointed out that the isthmus lies direct between our Australian colonies and the mother country. Moreover, it must not be forgotten that the strategic value of the Canadian-Pacific Railroad has not been increased by the positions recently acquired by the Russians and Germans at Port Arthur and Kiau-Chau respectively, and that every improvement of communications giving access to the East is most desirable.

A late Secretary of State for the United States some months ago said to the writer of these lines, that not only would a canal be made, but that the States could and would make it without any external assistance. Now at present there exists a treaty, known as the Clayton-Bulwer Treaty (made in April, 1850) between Great Britain and the United States of America. Divergent views are held in the States as to whether this treaty is still binding, on account of alleged English infringements of the same.

To briefly examine the treaty, we find that it is as follows (*vide* Volume XXXVIII. British and Foreign State Papers):

Article I. The Governments of Great Britain and the United States hereby declare that neither the one nor the other will ever obtain or maintain for itself any exclusive control over the said ship canal; agreeing that neither will ever erect or maintain any fortifications commanding the same, or in the vicinity thereof, or occupy, or fortify, or colonize, or assume, or exercise any dominion over Nicaragua, Costa Rica, the Mosquito Coast, or any part of Central America, etc.

Article II. arranges that in time of war the ships of either country are "exempted from blockade, detention, or capture."

Article III. defines that the construction of the canal is to be under the protection of the two parties to the treaty.

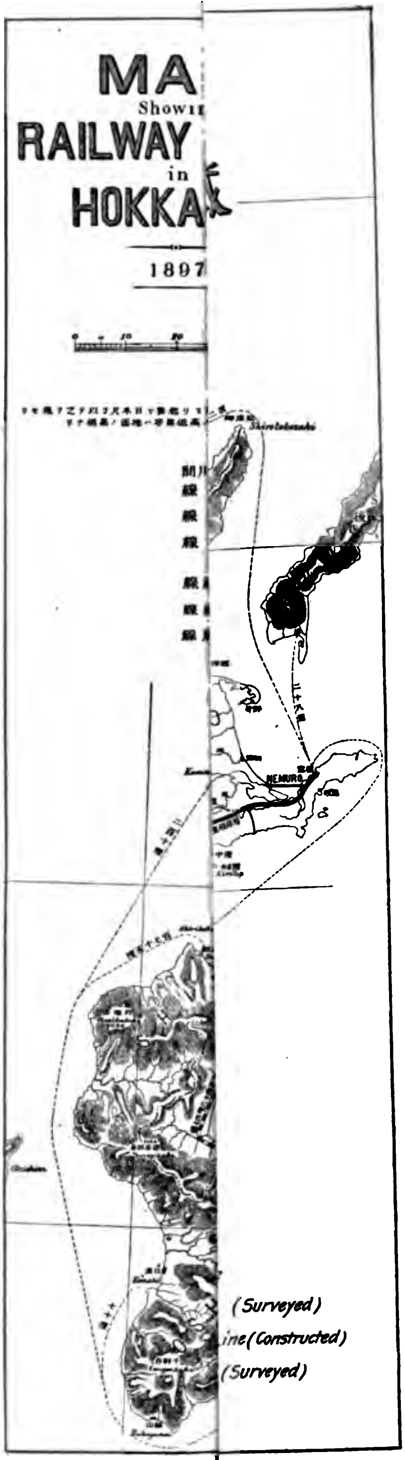
By Article IV. both governments were to facilitate the construction as most expedient, and maintain free ports at each end of the canal.

In Article V. both governments are to protect the canal when made, and guarantee its neutrality.

Beyond these articles come four more, but they merely elaborate the main idea.

Now it is claimed that this treaty was actually a compact made for a valuable consideration, and, that if either party defaulted, the agreement would then become terminable at the option of the injured party. If both parties kept to their contract, then the treaty was to be perpetually binding.

The American view is that, about the time Sir Henry Bulwer and Mr. Clayton, respectively British Minister and U. S. Secretary of State, were conducting their negotiations, England was extending her sphere of influence on the northern coast of Central America. It was an American fear that England's actions threatened a gradual total absorption of these regions between the boundaries of Colombia and Mexico. Therefore, thinking that English possessions in the New World already were too large, and being resolved, as she is to-day, that in case of conflict she would force England to withdraw entirely from the continent, the United States objected to our action. To avoid a second British America, on the mainland south of the Caribbean Sea, Mr. Clayton agreed that Great Britain should share with the United States the control of any canal made on this isthmus, provided that, for this concession,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Great Britain would cease from extending in these parts, and pledge herself not to annex any part of Central America.

So the treaty came into existence and was signed. Afterwards Sir Henry Bulwer and Mr. Clayton exchanged notes about the position of the British subjects in the neighborhood of Belize. There people had had timber-cutting rights from times immemorial, or ever since they had been there. Spain originally probably granted these rights, the various succeeding republics had continued them, and Sir Henry was of opinion that they still existed. Mr. Clayton, independent of the text of the treaty, concurred. During the progress of the Civil War, that raged subsequently in the states, it is asserted that Great Britain transformed the settlement of wood-cutters into a British Crown Colony. As a Crown Colony, Belize, or British Honduras, blossomed forth into various rights, and, not content with the valuable mahogany and logwood forests in its own limits, managed to expand into Guatemala, until it now covers some 14,000 square miles. This is an American view of the infringement, and consequent possible rendering void of the Bulwer-Clayton Treaty.

Mr. Frelinhuysen afterwards became Secretary of State for the United States, and was of opinion that these transgressions rendered it possible for the States to free themselves at will from the treaty, and gave formal notice to that effect to the British Foreign Office.

President Cleveland apparently did not take this extreme view, as his Secretary of State wrote twice in official despatches as if the treaty was still operative. But in 1881 Mr. Blaine wrote that: "The United States would claim with the Columbian Government the exclusive control of the Canal." He further said any combination of European Powers which neutralized it would be regarded by the States as "indication of unfriendly feeling." Mr. Blaine also wrote: "As Great Britain insists, by the right of her power, that her enemies in war shall strike her Indian possessions only by doubling the Cape of Good Hope, so the Government of the United States will equally insist that the interior, more speedy, and safer route of the Canal shall be remanded to the voyage around Cape Horn."

Undoubtedly the questions involved by this treaty have been the subject of considerable diplomatic correspondence, and there is more to come. Various American politicians have challenged its binding effect, and their views will have to be taken into consideration. Public opinion in the United States is fairly agreed that their Government must, diplomatically or otherwise, settle the question before commencing work on the Canal, and obtain an abrogation of the treaty. Senator Morgan heads a class of men who are quite impatient of anything of the nature of foreign control in American affairs, such as they consider these, and has prepared a Bill on the Canal scheme to that effect. He declares for the absolute neutrality of the Canal, but requires it to be built and controlled by his own nation.

Much has been heard of late of an Anglo-Saxon alliance, and many expressions of mutual good-will have been made by leading men on both sides of the water. But America has shown herself to be controlled by other than her leading men, and the "Hayseeds from the West," as they are facetiously termed by the Eastern States, to a very large extent forced war on Spain in opposition to the expressed views of the leading men, and are a class that ever preach that America is for the Americans. The good-will to England is in very many parts but mere veneer, and expressions that England has everything to gain and America nothing are plentiful amongst the masses. The Anglo-Saxon alliance is at present a not too hardy growth of sentiment to encourage the idea that America will give what she fancies is substance for shadow.

So we are brought to consider several possibilities: firstly, that America may fully abide by the treaty and work with us; secondly, that she may but partially do so; thirdly, that she will claim an abrogation of the treaty.

Evidently the first case is the most desirable for British interests both in peace and in war. The second appears to-day the most probable solution, and is one that in war will entail absolute neutrality of the Canal to all Powers alike. The third case is possible and strategically resembles the second, but would be a blow to our prestige and friendship.

The decision must perforce be left to the good sense and discretion of the American Government, but in any case we may bark but we cannot and must not bite. It is possible that unless we take the initiative and abrogate the treaty of our own volition, that the budding Anglo-Saxon alliance may receive a shaking that its too feeble roots may not be able to withstand.

When comparatively recently France made a proposition for the neutrality of the Canal, she asked what most suits the popular American fancy. England, however, objected on the grounds that in war-time she would not be able to use the Canal, that is to say, when she most requires it. England requires dual control and ownership in some form. The question is, Will she get it? and further, Is she prepared to put up the necessary money? If she fails so to do, the advantage of the treaty being in any way recognised is hard to perceive. If we are at war with any power, other than America, we shall be on an equal footing of neutrality with that power, plus the Canadian Pacific Railway. If we are at war with the United States evidently we could make no use of the Canal, and should have forfeited any pecuniary position that we possessed. War with the United States would mean an invasion of Canada, as the States, with their approximately 60 millions more population than Canada, would start in to remove the last remaining European flag from the continent.

Our retaliation would lie in driving her shipping off the sea and harassing her coasts. With the present inadequate and incompetent Canadian defence and militia arrangements, there can be little doubt that the outlook would be serious. As a matter of interest and but known to few, it is noteworthy that had the Venezuelan affair proceeded to its full possibilities, three columns would have been launched into Canada: one to seize the canals giving access to the St. Lawrence, one through the State of Maine to cut the railways, and the third to the west near Medicine Hat. The existence of a Nicaragua Canal under dual control would not, and never could, then avail us, although of great value to our adversaries. That must be recognized; but we need not, it is sincerely to be hoped, ever recognize the United States as adversaries except in commerce.

We are not in a position to forbid or command the construction of the Canal, no matter how great a strategic disadvantage it may become. Are we in a position to insist that it shall be of any value to us in case of war with nations other than our American cousins?

In the present state of affairs it looks as if we are not, and that the United States will elect to do what they think to be their own work unaided, and by absolute neutrality treat all nations alike. Therefore, there is wisdom in the counsel that the British Government shall *propose* a new treaty in lieu of the old, allowing no power but America to make or control the Canal, and to maintain its inviolate neutrality.

Probably negotiations are at present being quietly conducted between the United States, Nicaragua, and Costa Rica, to obtain their consent. If this can be verified, Great Britain will obtain thus a sign of "which way the wind is blowing."

By Captain Cecil B. Levita, R. A.
—In *Journal of the Royal United Service Institution.*

BOOK REVIEWS.

VanNostrand Science Series, No. 70, Explosive Materials. The Phenomena and Theories of Explosions and the Classification, Constitution and Properties of Explosives, by Captain J. P. Wisser. D. VanNostrand Co., 1898.

The original number 70 of this series bore the title of "Explosive Materials" and was a translation of a course of lectures, delivered by M. Berthelot, by M. Benjamin. It also contained a translation by Captain Wisser, of an historical sketch of gunpowder by Karl Braun, together with a bibliography of works on Explosives.

The present little volume has been entirely rewritten and is substantially new, though bearing the general title of the original number 70. It contains condensed into small space a large amount of useful information in regard to explosives and will prove a ready-reference book for those desiring to know the composition and formulae of modern explosives and will be a great convenience to both professional and non-professional readers.

The classification of explosive materials is exellent and definite. By specifying *two* classes of mixtures the difficulty of assigning an explosive to a class is overcome and the classification made much more useful, especially to the lay reader.

All details of the preparation of explosives are very properly omitted, except in case of a few of, what may be called, the more basic explosives, as nitro-glycerine, guncotton and black powder; in these the process of manufacture is briefly but clearly set forth; in other cases only general principles of production are given. The composition and formulae of all the important explosives are given, besides that of many others whose usefulness has not yet been proven. All the important explosion-equations are also included.

The author has adopted throughout Mendeléef's suggestion for determining relative ballistic properties of explosives, where this relation has not been determined by experiment. The method consists in taking the relative volumes of the gases at a certain temperature and pressure, produced by two explosives as comparing their efficiencies, and not attempting to determine the actual temperatures produced by the explosives. This simple method applied to the large number of equations of explosion in the text gives the reader an easy means of approximately comparing the efficiencies of many explosives.

The author's discussion of the action of brown powder in producing high velocities with low pressures is very attractive and satisfactory, provided all the premises be accepted. It is to be remarked, however, that the caution with regard to introducing unknown elements into our discussions, which led to the acceptance of Mendeléef's method of comparing ballistic properties, is not exercised to the same extent in this discussion.

A due sense of proportion in the volume has greatly limited the discussion of explosive phenomena in general, and of the supposed reactions and their origin. The discussions given have connected in the most plausible way some of the leading suppositions upon the subject. The great condensation, however, creates the impression, in more than one place, that we have an *established scientific* theory where none really exists, as for instance, in the explanation of sympathetic explosions by the combined suppositions of Abel and Threlfall,—synchronous vibration and vortex motion.

Besides a few typographical errors we notice the use of the word "force," page 12, where "energy" was meant, "reaction" for "equation" page 21, "benzine" for "benzene," page 50.

The type is clear and pleasant for so small a volume; the book is a condensed statement in a very convenient and useful form, giving the latest conclusions as to the compositions and properties of explosives.

S. E. T.

Customs of the Service. Colonel James W. Powell, U. S. Army. Kansas City, Mo.: The Hudson-Kimberly Publishing Co. 1899. Pp. 181. $1.50.

Colonel Powell has compiled a valuable little manual under the above title, which should prove very useful to our army, since many officers and non-commissioned officers, without much previous service or experience, are nowadays called to responsible positions, without being afforded the time or opportunity to acquire a knowledge of army customs in the old way of experience and observation.

The book contains short notes on the routine of duty, a good chapter on guard duty, one on grades and pay of officers and men, some interesting remarks on the general duties of the officers and men from the Captain down, a valuable chapter on subsistence and another on clothing.

The practical field service is considered in several short chapters, opening with a general dissertation on military instruction, comprising, in addition notes on the service of troops in campaign, transportation by rail and water, battles, marches, army sanitation and out-post duty.

The volume concludes with some useful information on army correspondence, and the manner of wording orders and writing out records of boards of survey and courts-martial and keeping company books and records.

J. P. W.

Examination of Water (chemical and bacteriological). William P. Mason. Pp. 135. New York: John Wiley & Sons. $1.25.

Professor Mason is one of the leading authorities on water supply and the analysis of Drinking Water in this country, and this little manual is the result of years of study and experience. In his earlier studies he was quick to perceive the sources of error and the limitations of the methods then in vogue, and lost no time in modifying them and in introducing valuable improvements in the apparatus used.

His work, therefore, represents the best knowledge on the subject today. The apparatus described is of the latest form, and the methods given are those which experience has shown to be the most reliable. The bacteriological section is particularly interesting, and comprises all that has been found practically useful to the water analyst.

The book is clearly written, well illustrated, tastefully bound, and of convenient size; indeed, it is a model handbook, and indispensable in any laboratory, dispensary or army hospital.

J. P. W.

Tactical Organization and uses of Machine Guns in the Field. John H. Parker, 1st Lieutenant, 13th Infantry. Kansas City, Mo.: Hudson-Kimberly Publishing Co. Pp. 196. $1.50.

Lieutenant Parker's work in the field as commander of the Gatling Gun Detachment in the Santiago Campaign has already given him an international reputation, and his report is quoted in all the principal military journals as authority on the subject.

After a brief introduction on the machine gun in general, the author gives us a valuable historical summary of the machine gun in the Franco-Prussian war, the Bannock-Shoshone Campaign of 1878, the siege of Alexandria, the Khivan Campaign, the Geok-Tepe Expedition, at El Obeid, at Santiago and at Omdurman. In every case the author adds some useful original remarks to those of the autorities generally quoted, showing much careful study of the subject on his part.

The next point considered is the proper organization of the machine gun batteries and their associated units. After discussing the French, Russian, and English systems, the uses and functions of this new arm, and its relations to the artillery, cavalry and infantry respectively, the author presents his views on the organization demanded by experience, which may be summarized as follows:

The tactical unit is the piece: the gun crew comprises 1 officer, 1 sergeant, 1 corporal, 6 privates and 1 driver; the battery should be 3 pieces; 3 batteries forming a battalion. An army corps (U. S.) would have 9 battalions with the infantry divisions, 3 with the cavalry division, 1 as a corps reserve.

An essay on the proper tactical use of machine guns on the march, with the outposts, and in battle, closes this compact and suggestive little volume.

The work constitutes a valuable addition to the literature of the subject, and will go far toward deciding the future of this new, but firmly established, piece of ordnance.

J. P. W.

Our Navy in the war with Spain, by John R. Spears. New York: Charles Scribner's Sons. 1899. Pp. 406.

The author of "The History of our Navy" has added another volume to the four previously published, no less interesting than its predecessors, and quite as replete with glorious deeds and brave actions. The subject is introduced by a description of the growth and composition of the White Squadron, the events that led to the popular feeling against Spain and the immediate causes of intervention in Cuba.

Himself an eyewitness to the events transpiring in the West Indies, the author very naturally gives a much more personal character to his narrative than he has in the other volumes of his *History*. While this is in some respects an advantage, it is also a disadvantage in that personal contact with some of the officers and not with others gives rise to prejudices; and events in one's immediate vicinity appear of more importance than those at a distance. Hence, while the present volume is written in a very intertaining style, full of vivacity, replete with incident, it has not the historic value of the four volumes of the *History*. The author's training as a naval man (having been educated at the Naval Academy), and as a newspaper correspondent, give him a great advantage, however, and will make his work in most respects authoritative.

The description of the actual conflict is very graphic, and reproduces the ring of battle, the clash of projectiles and armor, and the excitement pervading the sea and air with wonderful effect.

Dewey at Manila has given the world a picture that the American heart loves to dwell upon, and the author has proven himself equal to the task of portraying the work of our brave admiral:

" At last, when a little more than two miles away from forts and anchored squadron, the *Olympia* swerved to the right (west), so as to pass the Spaniards broadside to broadside, and then, turning to the captain of the ship, Dewey said, quietly:

" 'When you are ready, you may fire, Gridley,' and Gridley passed the order to the eager gunners in the *Olympia's* forward turret. The two long eight-inch rifles there were already trained on the Spanish flag-ship, and as the order was heard they made quick reply. Two darting flashes in the midst of a rolling cloud of smoke were seen, and with a shivering roar the projectiles were hurled at the doomed Spaniards.

" 'Almost instantly—it seemed like an echo,—came the sound of the other ships' of the Yankee squadron. It was at exactly 5.35 o'clock that the first guns on the *Olympia* were fired. Our ships were slowed down as they approached the Spaniards to give our gunners a better chance. The headway was just about right to carry the guns of the leader clear of the smoke they made, and seeing this, and that the Yankees were now well within range, the Spaniards worked their guns with redoubled fury. To the crews of the transports it seemed that 'never did spectators watch a more desperate game'. The water on every side of our ships was cut and slashed into foam and spray, while the guns at Manila reached out to fill the air about the transports, as well as the fighting ships, with screaming shot.

" Passing the anchored squadron at a range of a mile and a half, Dewey led his ships in front of the forts on Cavite Point, and then turning slowly about, went back at them with fresh batteries to starboard."

Santiago presented another picture of exitement and destruction:

"While yet the destroyers were afloat our shells were literally cutting the *Maria Teresa* to pieces. An eight-inch struck the shield of one of her 5.5-inch guns, passed through and exploded, ranging aft. 'The effect of the explosion was terrific'. Another entered the ship just under the after barbette, exploded on the gun-deck, ranging aft, with such damaging effect that 'all the men in that locality must have been killed or badly wounded, while the beams were ripped and torn, the bulkheads were shattered', and, what was infinitely worse, the fire-main was cut by the fragments of the shell before they passed out on the farther side of the ship.

"To the destructive effect of these shots was added the damage done by two twelve-inch shells that entered below the berth-deck, making one widened hole where they entered, exploding and completely wrecking the after torpedo compartment.

"With these huge projectiles came a hail of five-inch and four-inch and six-pounder shells so numerous and so deadly that it is impossible to follow them in detail, but when they burst amid her splintering decks and bulkheads there was no water to quench the quick-spreading flames."

These scenes the author pictures with vivid clearness, but the weary days of watching during the blockade, the nights without sleep passed by so many of the higher naval officer, in their desire to let no opportunity slip by, the strain upon the nerves that robbed them of sleep even when they sought a short rest,—these trials no pen can properly portray, and yet many who had no part in the fight deserve their country's gratitude for work which is always forgotten in the greater glory of the actual conflict.

The illustrations are numerous and full of interest, as they are mostly from photographs taken at the time, and the entire volume is a beautiful and artistic record of our navy in the war with Spain.

J. P. W.

INDEX TO CURRENT ARTILLERY LITERATURE.

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Abbreviations employed in index are added here in brackets.

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The spirit of conquest.—**Pop. Sc. Monthly**, February.

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CORRECTIONS.

Whole Number 35.

Applying corrections when ranging by the fork system:

P. 238, line 4, for "P" read "$\sqrt{n}$ multiplied by P_1."

P. 238, line 5, for "probable error" read "probable ranging error."

P. 241, line 3, for "one round" read "one ± round;" for "l rounds" read "l ± rounds."

P. 246, Table I, column q, last line, for ".0055" read ".0035."

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A SIMPLE METHOD OF LAYING GUNS FOR INDIRECT FIRE FOR THE 3.2 B. L. FIELD RIFLE.

BY ALSTON HAMILTON, SECOND LIEUTENANT FIRST ARTILLERY.

More or less inconvenience attends each method of indirect laying. Indirect fire, however, has its sphere, and is at times almost indispensable. It conceals those using it, prevents observation by the enemy of the bursts of his projectile, and thus prevents or tends to prevent the correction of the enemy's aim. If intelligently employed and properly executed it often proves to be a means of taking the enemy at a serious disadvantage. (See "Indirect Fire," *Journal United States Artillery*, Sept.-Oct., 1897, page 170.)

There are in use in Europe many different methods of indirect fire. They are all more or less complicated, and, from the article referred to, all require a quadrant of some kind, which must be used for each shot. As will appear, the firing virtually becomes direct after the range is established if the method which I propose is used.

We will suppose (and we will not be far wrong) that the indirect fire for field artillery has practically received no attention in our army. The absence of suitable instruments is mainly responsible for this.

I say "practically" above advisedly. I mean both "approximately" and "in a practical way."

We have, indeed, a description and a few specimens, extant, of the "Pointing Arc," a *beautiful* and *extremely accurate* instrument. I had the privilege of using it at target practice at Aldie, Va., in October, 1897. The results were surprisingly gratifying. I cannot say too much in praise of the instrument. There is the same trouble with this instrument, however, that exists with many desirable things; the demand exceeds the supply. There are, to the best of my belief, only a few of them in existence. The battery to which I am attached *had one*, which Major James M. Lancaster, Fourth Artillery, kindly allowed us to use. So far as I can learn no other battery has had one.

As a matter of fact each battery of light artillery should have as many Pointing Arcs as it has guns, if Pointing Arcs are to be used.

My purpose is not in any way to attempt to supplant any existing method with accurate instruments. It is intended to supply the need caused by their absence. I feel confident that satisfactory results would attend the method to be given.

This method will be found practical, useful and always available; such is my belief.

In this method only one thing is needed to supplement the present equipment of each battery; a spirit level. In the absence of a spirit level a board with a fairly true edge and a plummet may be constructed by any one, and a line drawn where the string of the plummet should lie when the gun is horizontal. (See figure 5.)

Several stakes, five or six feet in length, are necessary, as will appear. These should be carried on the caissons with the tools. It is best to make them beforehand and shoe them with iron (see figure 4) and to paint them a white color so that they may be easily seen. Alternate white and black horizontal rings are still better. By preparing them beforehand they may be made straight and true and readily distinguishable. They add practically no weight to the equipment.

As the battery approaches its position a party equipped with the usual range finders and the stakes indicated proceed in advance to the hither side of the crest of the intervening hill, and (in order to avoid being observed by the enemy and prematurely advertising the presence and direction of the battery) they keep concealed by the crest of the hill, allowing their heads to show only when necessary.

They then plant a stake on the hither side of the crest so that a line drawn from it to the target will pass through the position in which it is desired to place the first gun. This can be done as follows:

Plant a stake at A, Figure 1, which point you judge to be on the desired line. Stand at A, and by means of the 90-degree prism of the Range Finder (Weldon) plant the stake "B;" B AT = 90 degrees. Then with A and B plant C. If C is far off the desired line, you have still a basis on which to make corrections. Suppose that A C passed to the right of the ground to be occupied by the first gun; select another point, A, on the left of C, and proceed as before. If the position in which it is desired to place the gun admits of some latitude, place the first gun in prolongation of A′ C′. If the position of the gun "select itself," then the method described by First Lieutenant H. L. Hawthorne, First Artillery, in the Nov.-Dec., 1897, *Journal United States Artillery*, is to be followed. The two stakes having been placed, the range may be readily found both to the gun and the target. Their sum is the range to be communicated to the battery. If it is desired to place more than two stakes, others may readily be placed in the same line and any desired distance apart.

Upon the arrival of the battery the gun is placed somewhere in the line A′ C′.

This gun having been established, the guns remaining may be established by aligning them each on its own row of stakes similarly established, or if the ground occupied by the battery is uneventful, rows of stakes may be established parallel to the first and the guns placed each in prolongation of its own row. In making the trial shots (after all preliminary work) the results should be signalled after each shot, and all the guns that participate in the firing should participate in the trial shots. If concentration of fire is desired on some particular point the lines of stakes should be separately established, or if already established parallel to each other, correction may be made on the deflection scale as follows:

I. = Interval in yards between gun originally established and gun to be corrected by deflection.

R. = Range in yards.

Number of points to be taken on deflection scale, to the right or left according, as the gun is on the left or right of original gun = N.

$$\text{Then N.} = \frac{1000}{3}\,\frac{I}{R}\left(\text{since one point} = 10^{1} = \tan^{-1}\frac{3}{1000}\right)$$

Example : Range 2400 yards.

Interval 12 yards to the right (*i. e.*, gun is to right of original gun).

$$N. = \frac{1000 \times 12}{7200} = 1\tfrac{2}{3} \text{ points left.}$$

This preliminary work should be done with care and, if necessary, with deliberation, as the presence of the battery, or at any rate its exact location are, until firing begins, presumably unknown. *So much for direction.*

In order to properly *elevate* the pieces a horizontal line is to be found by means of which to give elevation with the very elementary means at hand.

Place the tangent sight in its socket. Set it at zero, and place the spirit level in the place marked out for it (to be mentioned later), and level the gun by elevating or depressing the muzzle. The relative elevation of one wheel over the other does not affect the accuracy of the fire, the line of sight (when the rear sight is set at zero) being parallel to the axis of the bore. It should be sought, however, to place the wheels on the same level, as elevation of the piece, when one wheel is higher than the other, gives a horizontal component, owing to the fact that the axis of rotation is not horizontal, and correction by the trail handspike will be necessary. This applies with the same force to *direct* fire. (The spirit level should be nearly on the line of metal in any case in indirect fire.

The tangent sight having been set at zero (horizontally and vertically), and the axis of the bore made horizontal by the spirit level (after first being placed in the prolongation of the line of stakes), look through the front and rear sight and note where the line of sight strikes a stake or the ground. Mark this point conspicuously so that it can be aimed at. The point of contact of the wheels of the gun with the ground should be marked with stones or stakes so that it can always be fired from that position. If in its original position the gun is aimed at the point marked and the elevation due to the range is given, the gun will be firing at S^1, at the same elevation as itself, and at the given range.

Now to correct for difference in level.

The party on the hill have supposedly signalled the range and the known or estimated difference in level of gun and target, stating which is higher. Both range and difference of level should be signalled in *yards*.

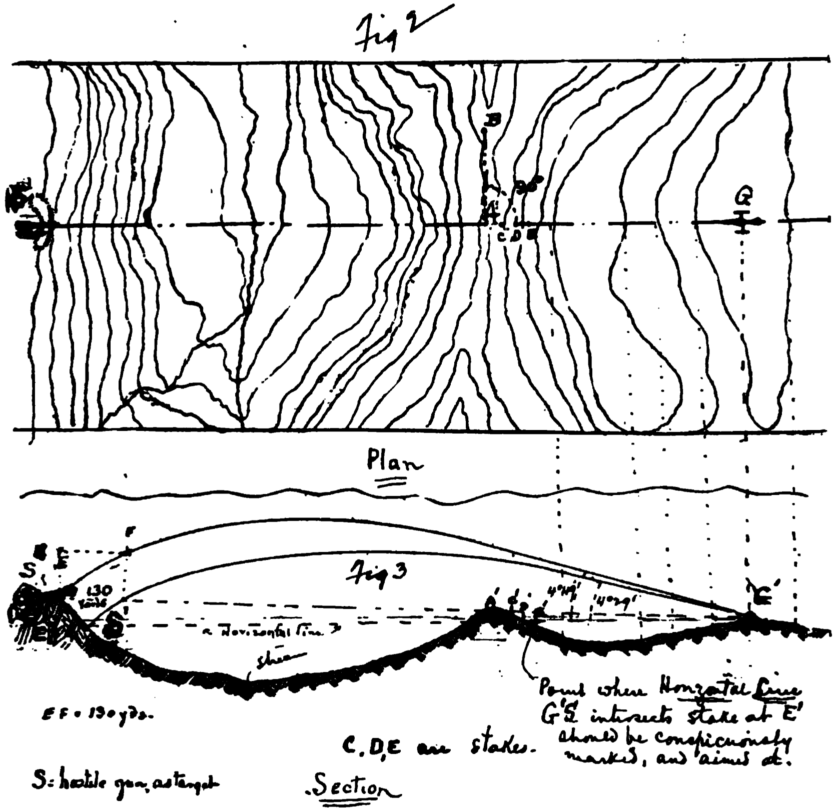


Fig 2
B
30°
A
C D E
G
Plan
Fig 3
S
E
F
130 yards
S
Horizontal line
shoe
4° 49'
4° 29'
E'
Point where Horizontal Line G'S intersects stake at E' should be conspicuously marked, and aimed at.
EF = 130 yds.
C, D, E are stakes.
S: hostile gun, as target
Section

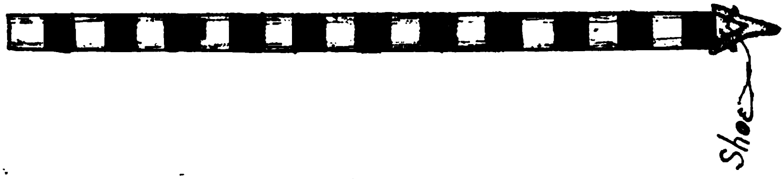
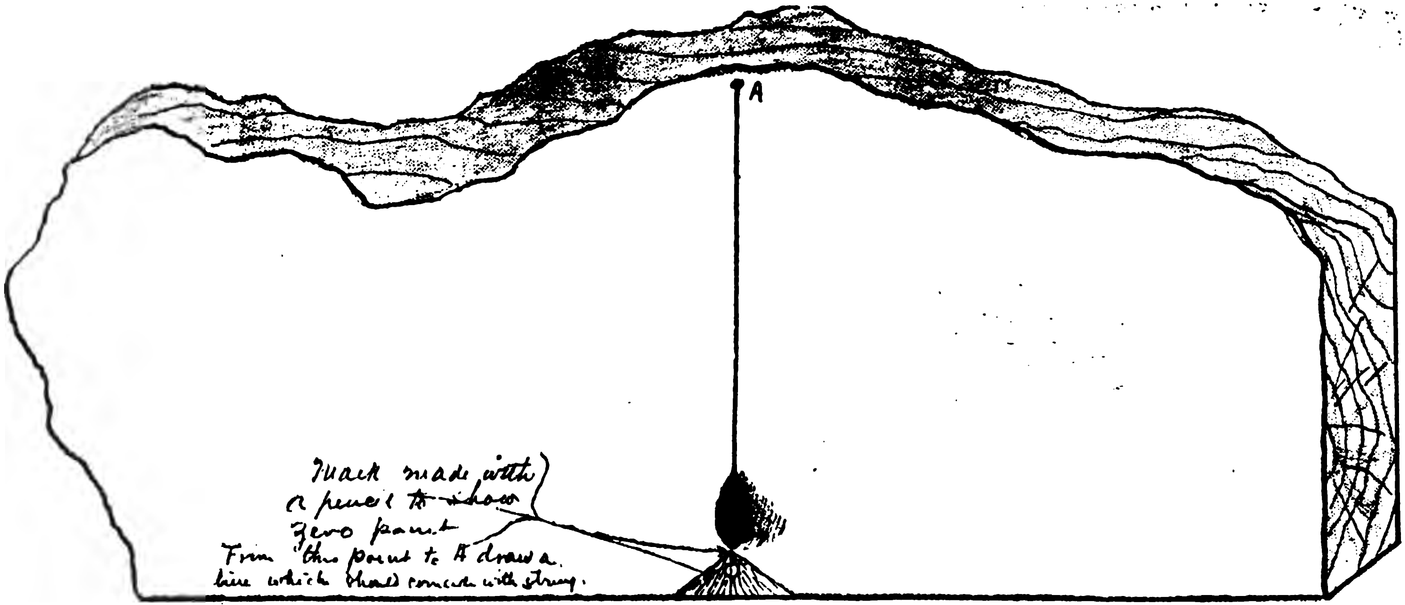

Shoe

FIG. 4.



Mark made with a pencil to show Zero point

From this point to A draw a line which should coincide with string.

Figure 5

From these the angular difference of level is known as follows:

N. = difference of level in yards.

M. = range in yards.

$\frac{N}{M} = \tan \theta =$ tan. angular difference of level.

$\tan 1' = 3/10000.$

$\frac{10000\ N}{3\ M}$ = tangent of angular difference in level expressed in minutes, and may be applied directly to the tangent scale.

A table containing all reasonable differences of level in yards and all ranges could easily be made (see table) giving, by interpolation, the proper difference of level in *any* case.

Table.—Correction for difference in level.

Difference of level in yards.	20		30		40		50		60		70		80		90		100	
Range.	*deg*	*min*	*deg*	*min*	*deg*	*min*	*deg*	*min*	*deg*	*min*	*deg*	*min*	*deg*	*min*	*deg*	*min*	*deg*	*min*
1000	1	09	1	43	2	18	2	52	3	27	4	01	4	35	5	10	5	44
1500	0	42	1	17	1	43	2	09	2	35	3	01	3	26	3	52	4	18
2000	0	34	0	52	1	09	1	26	1	43	2	00	2	18	2	35	2	52
2500	0	28	0	43	0	58	1	11	1	25	1	40	1	55	2	09	2	23
3000	0	23	0	34	0	46	0	57	1	09	1	20	1	32	1	43	1	54
3500	0	20	0	30	0	40	0	50	1	00	1	10	1	20	1	30	1	40
4000	0	17	0	26	0	34	0	43	0	52	1	00	1	09	1	18	1	26
4500	0	15	0	23	0	30	0	38	0	46	0	54	1	02	1	10	1	17
5000	0	14	0	20	0	27	0	34	0	41	0	48	0	55	1	02	1	09

If a contour map is available accurate results may be expected from the beginning. In the absence of definite information as to difference in level, and especially when the gun and target do not differ greatly in altitude, it may be assumed, to begin with, that their level is the same. The first shot will give data for correction by "bracketing" the target. In order to mechanically correct the sight for difference of level, set the sight at the indicated range, using the yard scale, and keeping in view the kind of projectile to be used, as the yard scales differ somewhat from each other, for shell and shrapnel. Run the eye across and read the elevation in degrees and minutes. Add or subtract the difference in level in minutes of arc and run the sight up and down to correspond to this. It should be kept in view, which is higher, the gun or the target, the difference being added if the target is higher, etc. I have known it to be added when it should have been subtracted, which justifies this apparently superfluous caution.

When the addition or subtraction has been executed on the scale, look at the yard scale again, take the range there indicated for the correct range. There is now no further use for the spirit level, and we have practically direct fire, so far as the gunner's work is concerned.

An example will indicate what I mean.

Assume—

Range = 2700 yards.
Difference of level = + 20′ (target higher.)
Percussion shrapnel are being used.

The shrapnel yard scale is side by side with the tangential scale on the rear sight.

Place the sight at 2700 yards.

Look at the tangent scale. It reads 4° 29′. Add 20′. It becomes 4° and 49′. (See Figure 3).

Look now at the yard scale, and it now reads 2830 yards, this is to be used as the corrected range, and is, further, to be corrected by observation, as is usual in bracketing. The result of each shot should be signalled to the battery commander by the party on the hill until the range is satisfactorily established.

Brief signals should be used.

"*O*," "*S*," "*R*," "*L*," "*H*," "*Lost*," indicate, respectively, "Over," "Short," "Right," "Left," "Hit" and "Lost." The letters *R* and *L* should be followed by the estimated number of yards which the projectile struck to the right or left. *O* and *S* are sufficient in themselves, and it is distinctly against the principles of artillery practice to seek to estimate distances beyond or short of the target. Colonel Rogers says that an increase or decrease of about 1/10 of the range should be made irrespective of apparent distance over or short. I have tried both, and know from experience that it is a bad plan to estimate distances short or over. The country is often deceptive, due to its conformation.

If time shrapnel are used the signals "*H. B.*" (No. of yards) and "*O*" and "*S*" are used, meaning "Height of Burst" and "Over" or "Short." The "Height of Burst" is given in yards.

Yards are the units of measure throughout, in order to avoid confusion and to save time wasted in signalling also the unit of measure.

The plan above outlined is the one I had intended to suggest had indirect fire proved necessary in Cuba, and Lieutenant Kenly and I had both provided the spirit levels necessary. Seats were prepared on the guns of the battery and the spirit levels tested.

The kind of warfare and the circumstances did not justify the use of indirect fire. Had circumstances differed somewhat it would have been advisable to resort to it, as the terrain was admirably adapted to it.

A word further about the "Pointing Arc." It is a delicate instrument, necessarily so because of its extreme accuracy. It is a much more delicate instrument than the breech sight, which I have known to be deformed by hard knocks to such an extent that I have had to take it apart and straighten and adjust the parts. If the "Pointing Arc" were deformed to that extent it would have to be sent to the maker or to a skilled mechanic for repairs. No seats are provided on the guns for the "Pointing Arc." Lieutenant Hawthorne and I *made* the seats in two of the guns in 1897 with great care at Aldie, Va., in October, 1897. The first shot from my gun, so prepared, struck within three yards of a small target twenty-three hundred yards away and beyond a hill.

The accuracy of the "Pointing Arc" is, in my opinion, unquestionable. The difference of level in the case referred to above was 50 minutes, and was found from a contour map.

With an accurate contour map such results are to be expected. In the field without a contour map all that one can hope for (as is also the case with the range finder) is, in the beginning, to eliminate as much error as possible.

The errors having been thus far eliminated to some extent we have, so to speak, a point of reference on which to base corrections of all kinds.

The first shot should be as good as is possible under the circumstances; using the information derived from the results of this shot, improve the aim by orthodox bracketing, and the results will be almost invariably gratifying. In this connection the rules laid down by General John I. Rodgers, in his pamphlet on Light Artillery Practice (Artillery Memoranda No. 2, H. Q. A., A. G. O., Washington, D. C., June 7, 1898), may, with profit, be closely adhered to, as they are the outcome of experience and sound logic.

NOTE ON PREPARING THE SEAT FOR SPIRIT LEVEL ON 3.2-INCH GUN.

To mark a place on the gun for the spirit level we first find that the jacket of the 3.2-inch gun is cylindrical in form to a point about twelve inches in rear of the axis of the trunnions, thus giving a cylinder twelve inches in length, whose elements are parallel to the axis of the bore.

The exterior of the jacket takes a conical form from the anterior termination of this cylinder to a point near the rimbases. Place the spirit level (on the line of metal, preferably,) on the gun. Bring the bubble to the center by using the lazy tongs, the long axis of the spirit level lying in the direction of the axis of the bore. Then outline the base of the spirit level on the cylindrical portion of the breech and scrape away the paint in the interior of the figure thus described. This leaves a clean metal cylindrical surface on which the level may rest, thus eliminating error that may arise from irregularity in the paint or that may be owing to abrasions at any time.

The seat is thereby plainly marked.

The seat should not be marked out until the accuracy of its position is verified by comparison with results obtained by placing a small spirit level, when obtainable, in the smooth sector of the breech, which sector is a true cylinder described about the axis of the bore. Care should be taken to keep it parallel to the long axis of the bore, which may be readily done by observing the position of the level relatively to that of the slotted sectors adjacent to the smooth one.

A NOTE ON THE CALCULATION OF THE TRANSVERSE DIMENSIONS OF STEEL GUNS.

By C. GAUTIER, Captain of Artillery.

[Translated from *Revue d'Artillerie*, July, 1898.]

The calculation of the transverse dimensions of guns is generally made by the application of the theories of Lamé and General Virgile. By formulas that are deduced from these theories the stress that the metal is subjected to may be calculated at each point of the several concentric tubes of which the gun is supposed to be built up. It is assumed for the problem that these stresses are not to exceed a certain amount and are not to impose too great deformations upon the metal.

In practice in planning a gun the following method is habitually used. Certain values for the thicknesses of the walls are assumed tentatively after comparison with a piece already existing, then the interior pressure is calculated, and also the proper shrinkages, in order that the gun may work under admissable conditions. If the interior pressure thus calculated differs from the known pressure that will result from the conditions under which the gun is to be fired, then the thicknesses of the walls are modified and, continuing thus, the dimensions are calculated by successive approximations.

In general, the metal is considered to be working under acceptable conditions when the tension at each point (directed along the tangent to the circle through the point) does not exceed a certain fixed value, which is taken small enough to take into account stresses acting in other directions.

The calculation by approximations is laborious and inexact. The purpose of this note is to indicate a method by which the calculation can be made directly. This method is now employed at the School of Application of Artillery and Engineering.

Let us suppose that the same metal is used for the tube and the hoops, and that the limit T, that will be assigned to the tension, is constant for each. This condition appears reasonable at the present day, since the inner tube can now be made of harder metal than formerly. The modulus of elasticity will also be the same.

The problem then may be put thus: What thicknesses are to be given to the concentric cylinders of a gun of a certain caliber in order that the tension at the inner surface of all the tubes will at firing attain a uniform value T?

First of all, the number of concentric cylinders that are to form the gun must be determined. In this matter the theory does not give a practical solution. It is known that for a given total thickness of wall the more tubes there are the stronger will be the cannon; but difficulties of construction place a limit. If in this matter we do not wish to innovate, we may take two cylinders (but one hoop) for calibers up to about 120 mm (4.7"), and 3, 4 or 5 cylinders successively, as the caliber becomes greater than 120 mm. (4.7"), 180 m. (7.0"), and 240 m. (9.4".)

We are led, however, to ask if the time has not arrived when we might try at least for the small calibers to build guns made up of a great number of thin tubes specially treated.

Remarkable resisting qualities can be given to such thin tubes, and the employment of a large number would not be a difficult matter. Guns thus constructed would have, in a large degree, most of the advantages of wire-wound guns without having their drawbacks, and in this way the cannon of minimum weight might be secured.

However this may be, let us denote by n the number of tubes of which the gun is to be constructed.

Let $r_0, r_1, r_2, \ldots r_n$ (following the method introduced by Major Henry) be the reciprocals of the squares of the radii of the tubes, r_0 corresponding to the interior radius:

$$(1)\ r_0 = \frac{1}{R_0^2},\ r_1 = \frac{1}{R_1^2},\ \ldots\ r_n = \frac{1}{R_n^2}.$$

The caliber being given, R_0 and consequently r_0 are also known.

These auxiliary quantities ($r_0, \ldots r_n$) have the effect of changing the curves of tensions and pressures given by the equations of Lamé into a series of right lines which gives us instead of an often inextricable calculation for the hooping a simple, elegant and rapid graphical solution.* But this supposes always that the thicknesses are known; now, it is the determination of these that we propose to make here.

Let us designate the pressures at the surfaces of contact by p_0, p_1, p_2, . . . p_n, the interior pressure which the gun is to support

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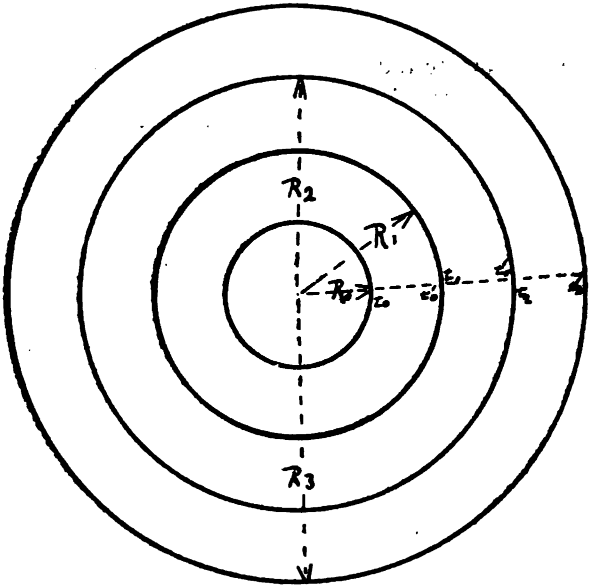
* See on this subject: Cours de l'Ecole d'application de l'artillerie et du génie. Bouches a feu, May, 1894, and following editions.



being p_0. This pressure results from the ballistic conditions imposed on the gun, and is, therefore, a given quantity. The outside pressure, p_n, may be considered as zero.

Let t_0 and t_0^1, t_1, and t_1^1, . . . be the tensions on the inner and outer surface of each tube successively. If it is desired that each of these tubes during fire shall work in the same manner, we have $t_0 = t_1 = t_2 \ldots = t_{n-1} = T$.

The problem now is to seek for a law connecting the thicknesses with the given quantities: n, r_0, p_0 and T.

The equations of Lamé give:

EQUATIONS A.

1st tube.

$$T - p_0 = t_0^1 - p_1$$

$$\frac{T + p_0}{r_0} = \frac{t_0^1 + p^1}{r_1}$$

2d tube.

$$T - p_1 = t_1^1 - p_2$$

$$\frac{T + p_1}{r_1} = \frac{t_1^1 + p_2}{r_2}$$

(n − 1) tube.

$$T - p_{n-2} = t^1_{n-2} - p_{n-1}$$

$$\frac{T + p_{n-2}}{r_{n-2}} = \frac{t^1_{n-2} + p_{n-1}}{r_{n-1}}$$

n^{th} tube.

$$T - p_{n-1} = t^1_{n-1} - p_n$$

$$\frac{T + p_{n-1}}{r_{n-1}} = \frac{t^1_{n-1} + p_n}{r_{n-1}}$$

We have thus $2n$ relations among the $n-1$ unknown values of p, the n values of t^1 (all unknown)and the n unknown values of r; that is, there are $3n-1$ unknown, and $n-1$ relations are still needed.

These relations are found by choosing a law of variation for the radii that gives one equation per joint, or $n-1$ equations in all, and this law should also be so selected as to permit the easy elimination of the quantities that are not needed, viz., the r's, the p's, and the t's, leaving r_0, p_0, and T.

Now, among all the laws that may be adopted, the best known, that of Gadolin, permits, as we shall see, a very simple elimination.

This law asserts that the resistance of a built-up gun of given total thickness is a maximum when the radii of the tubes of which it is composed are in geometrical progression.

It is expressed by the following $n-1$ relations:

$$\frac{R_0}{R_1} = \frac{R_1}{R_2} = \frac{R_2}{R_3} = \text{etc.}$$

or taking into account equations (1):

$$(2) \quad \frac{r_1}{r_0} = \frac{r_2}{r_1} = \frac{r_3}{r_2} = \text{etc.}$$

Admitting the law, therefore, and adding these $n-1$ relations (2) to the $2n$ of Series A, we obtain $3n-1$ relations, and the problem can now be solved.

Before making the calculation it is necessary to explain the use of the law of Gadolin, which, in practice, can hardly be followed. This law, as a matter of fact, gives such little thickness to the inner tube that it would cause inadmissable sagging, especially with the heavy outer hoops, which are also a consequence of the law.

Now, though the law of geometric progression may really give a maximum for the resistance corresponding to a given total thickness, yet this maximum is not very accentuated. In reality, what is gained in passing from one mode of distribution to another is negligeable, and when the total thickness of a gun is fixed the conditions of resistance are practically not modified by changing the thicknesses of the various parts.*

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* Suppose a cannon of about 155 mm. (6-inch) to be composed of three concentric tubes, and that its total thickness is determined for a tension of 20 kg. per square millimeter during firing, the radii of the tubes being in geometrical progression. Now, change the order of the thicknesses without changing the total thickness so that the least thickness will belong to the outer tube. This is an extreme case, and yet we find that the tension under which the gun now works does not exceed 21 kg. The diminution of resistance is thus insignificant.

We will proceed thus. We will admit the law of geometric progression simply for the possibility of the calculation. We will, therefore, introduce the relations expressed by equations (2). When, then, by this means we will have determined the total thickness of the gun, we will distribute this thickness among the several tubes according to any suitable consideration as, for example, according to the requirements of fabrication.

Let us put—

$$y = \frac{r_1}{r_0} = \frac{r_2}{r_1} = - - - = \frac{r_n}{r_{n-1}},$$

whence—

$$(3)\ r_1 = y\,r_0,\ r_2 = y^2 r_0,\ - - -$$
$$r_n = y^n\,r_0$$

All depends now on finding y, which leads to the elimination of the r's, the t's, and the p's between Series A and equations (3).

For this let us substitute all the values of the r's taken from (3) in Series A. Let us also take all the values of the t's from the first line of this series and substitute them in the second line. We thus obtain the following series, from which the r's and the t's have disappeared.

SERIES B.

1st tube.

$$\frac{T+p_0}{r_0} = \frac{T+2p_1-p_0}{y\,r_0}$$

2d tube.

$$\frac{T+p_1}{y\,r_0} = \frac{T+2p_2-p_1}{y^2\,r_0}.$$

n^{th} tube.

$$\frac{T+p_{n-1}}{y^{n-1}\,r_0} = \frac{T+2p_n-p_{n-1}}{y^n\,r_0}$$

This gives as a general formula for the m^{th} tube:

$$y\,(T+p_{m-1}) = T+2p_m-p_{m-1}$$

which may be written—

$$(y+1)\,(T+p_{m-1}) = 2\,(T+p_m)$$

or—

$$T+p_{m-1} = \frac{2}{y+1}\,(T+p_m)$$

The elimination of the p's takes place then of itself in passing step by step from the n^{th} tube, for which we have—

$$T+p_{n-1} = \frac{2}{y+1}\,T,$$

up to the first tube, which introduces the single known pressure p_0. This successive elimination gives

Series C.

n^{th} tube. *$(n - 1)$ tube.*

$$T + p_{n-1} = \frac{2}{y = 1} T \qquad T p_{n-2} = \left(\frac{2}{y+1}\right)^2 T \ldots$$

1st tube.

$$T + p_0 = \left(\frac{2}{1+y}\right)^n T$$

The last equation of this series gives—

$$(4) \quad y = 2\left(\frac{T}{T+p_0}\right)^{\frac{1}{n}} - 1$$

which is the value sought.

The auxiliary unknown y permits now the crlculation of the thickness $E = R_n - R_0$, which is to be given to the gun.

Taking into account (1), and (3) we have—

$$R_n^2 = \frac{R_0^2}{y^n}$$

whence—

$$E = R_n - R_0 = R_0\left(\frac{1}{y^{\frac{n}{2}}} - 1\right)$$

and on introducing (4)

$$E = R_0 \left\{ \frac{1}{\left[2\left(\frac{T}{T+p_0}\right)^{\frac{1}{n}} - 1\right]^{\frac{n}{2}}} - 1 \right\}.$$

Such is the formula which allows us to calculate the thickness E of a gun, as a function of the given quantities of the problem, n, T, p_0, *and* R_0. All that remains then is to distribute this value arbitrarily among the different tubes.

To complete the problem the shrinkage must be determined and the tensions and pressures for a state of rest calculated. For this purpose the diagram of Major Henry may be used, as all the elements of it are now known. We will not describe the constructions to which this leads, but refer the reader for detals to the course of the School of Application, remarking, however, that these constructions lead rapidly, in all cases, to the complete solution of the hooping.

[Translated by GEO. BLAKELY, 1st Lieutenant, 2d Artillery.]

THE ARTILLERY AT SANTIAGO.

By C. D. PARKHURST, Captain 2nd U. S. Artillery, Commanding Light Battery F.

The attack upon Fort San Juan was supported by the Gatling gun detachment, whose commander, Lieutenant Parker, had been sent forward with the somewhat vague order to "make the best use he could of his guns." He got three of them into position with the firing line just before the storming of the hill, and poured a destructive stream of bullets into the Spanish trenches at the critical moment of the assault. The Hotchkiss guns that figured at Quasimas were with the second cavalry brigade, and Colonel Wood reported that they were handled with "conspicuous gallantry." The field artillery played no great part in the battle. General Shafter states that when Grimes' battery—the only one brought into action—opened fire, early in the morning, upon the San Juan blockhouse, "this fire was effective, and the enemy could be seen running away from the vicinity of the blockhouse." Evidently, however, they came back again when the bombardment, which seems to have done no noticeable damage, was over.*

During the night the chief artillery officer, Major Dillenback, came up from El Pozo with Grimes' guns and the two batteries that had been held in reserve there. All these went into position on the heights, with orders to open, at dawn, on the nearest part of Santiago, the center of the Spanish position. "We ought to knock that part of the town to pieces in a short time," Shafter told Colonel McClernand, but this proved too much to expect of a dozen 3-inch field pieces, their first shots drew so warm a reply that they ceased firing and withdrew all the way to El Pozo again.*

Extracts from *Our War With Spain.*
Written by RICHARD H. TITHERINGTON,
The Munsey, April, 1899.

With the above as a text, and the official reports of all of those engaged, as vouchers, it is now proposed to give some light upon the artillery at Santiago, from an artillery standpoint; this too, although the writer has heretofore consistently declined from writing anything of a general nature for publication; as shown by the above extracts history is being falsely written, and "even the worm" has "turned at last."

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* In his interesting narrative, "The Gatlings at Santiago," Lieutenant Parker states that not a shell struck the San Juan blockhouse or exploded near it. The Lieutenant perhaps exaggerates the work of his machine battery and depreciates that of the artillery, but his statements of fact are presumably trustworthy.

* Lieutenant Parker's somewhat caustic account of this exploit of the artillery is that the gunners "fired four shots, and then withdrew with more haste than dignity. They remarked, 'This is the hottest fire to which artillery has been subjected in modern times,' and lit out to find a cooler place. They found it—so far in rear that their fire was almost equally dangerous to friends and foes on account of the close proximity of the two firing lines."

It is to be distinctly understood that the writer does not pose as an apologist for the artillery, but simply as a plain narrator of facts that have come under his observation, or as borne out by official records now before him; it is also to be understood that anything in the nature of criticism that may appear is not written in any fault-finding or captious spirit, but simply as a narrative of events affecting the artillery, over which it had no control.

Early in May the light batteries of artillery found themselves in camp at Port Tampa, Florida, organized as follows:

Brigadier-General WALLACE F. RANDOLPH, U. S. V.,
Commanding Brigade.

1st Battalion:—

Major James M. Lancaster, 4th Artillery, Commanding.

1. Light Battery A, 2nd Artillery—
   Captain George S. Grimes, 2nd Artillery, Comdg.
2. Light Battery F, 3rd Artillery—
   Captain Ramsey D. Potts, 3rd Artillery, Comdg.
3. Light Battery C, 3rd Artillery—
   Captain Joseph M. Califf, 3rd Artillery, Comdg.
4. Light Battery F, 2nd Artillery—
   Captain C. D. Parkhurst, 2nd Artillery, Comdg.

2nd Battalion:—

Major John W. Dillenback, 2nd Artillery, Commanding.

1. Light Battery D, 5th Artillery—
   Captain Frank Thorp, 5th Artillery, Comdg.
2. Light Battery F, 4th Artillery—
   Captain Sidney W. Taylor, 4th Artillery, Comdg.
3. Light Battery F, 5th Artillery—
   Captain Henry J. Reilly, 5th Artillery, Comdg.
4. Light Battery B, 4th Artillery—
   Captain Harry R. Anderson, 4th Artillery, Comdg.

3rd Battalion:—

Captain Allyn Capron, 1st Artillery, Commanding.

1. Light Battery E, 1st Artillery—
   Captain Allyn Capron, 1st Artillery, Comdg.
2. Light Battery K, 1st Artillery—
   Captain Clermont L. Best, 1st Artillery, Comdg.

All of the above were four-gun batteries, organized with four-horse teams, or upon the peace, or instruction footing: material, new men, and new horses were however being supplied as rapidly as possible to expand them all to six-gun batteries, with six-horse teams; but this material, the horses and the men had not been received at the time the organization sailed for Cuba; hence on departure the batteries accompanying the expedition were forced to go as *four*-gun batteries with *six*-horse teams.

Even had the expansion been completed prior to June 14th, the final day of sailing, it is doubtful if the battalion could have been taken as one of six-gun, six-horse team batteries, for the transportation available for horses and battery material was limited to a degree, and where four six-gun, six-horse team batteries could have been taken is beyond the writer's knowledge. As will be seen there was difficulty enough as it was, and all available space was consumed by the sixteen guns that were sent, and no room appeared to be available upon any transport to have taken twenty-four guns, and their necessary horses.

The months of May and first part of June, were zealously and diligently used in drilling and in organizing all the batteries for the coming field service, in which all expected and hoped to take part. As fast as received the new horses were broken in as best they could be to their new duties, and the new drivers necessary for the six-horse teams were as rapidly as possible taught their new duties; while the *old* drivers, heretofore taught and accustomed to handling but *four* horses in a team, had to be taught the difference between that kind of driving, and that involved in handling six horses.

And, as always happens on the receipt of new horses, the majority of them came down sick with distemper, so as to be unfit for work in many cases. Though the greater number were fair horses, and took kindly to their new work, and readily yielded to instruction, yet they were called upon to embark upon the expedition long before they were either well instructed, or, in many cases, were free from the distemper, and the attending debilitation; hence, when they sailed, the batteries could not be said to be in first-class condition.

The expedition as finally organized was announced in General Orders No. 5, Headquarters Fifth Army Corps, dated Tampa, Florida, May 31st, 1898.

Paragraph 5 of the order says:

"Four batteries of light artillery, to be commanded by a Major to be selected by the commanding officer of the light artillery brigade."

Paragraph 6. Two batteries of heavy artillery, to be selected by the commanding officer of the siege artillery battalion, with eight (8) siege guns, and eight (8) field mortars.

(See report of General Shafter—Operations at Santiago. Page 148. Report of the Major General Commanding the Army.)

As a consequence of this order the light batteries finally selected, and their battalion commander were as follows:

Major John W. Dillenback, 2nd Artillery, commanding battalion.

1. Light Battery E, 1st Artillery—
   Captain Allyn Capron, Commanding.
2. Light Battery K, 1st Artillery—
   Captain C. L. Best, Commanding.
3. Light Battery A, 2nd Artillery—
   Captain G. S. Grimes, Commanding.
4. Light Battery F, 2nd Artillery—
   Captain C. D. Parkhurst, Commanding.

Whether the fact that the letters of the batteries comprising this battalion spelled "F A K E," when read backwards, had anything to do with its after vicissitudes, I will leave for those of a superstitious mind to determine. It was commented upon and laughed about at the time, before it sailed, and we were known as the "Fake" battalion.

When it came time to load up it was found that the limitations of the transports were such that the battalion as an organization could not be accommodated upon any one ship; nor could all of the property and equipment of two of the batteries be taken even upon one ship. Although this was to be regretted, it still was beyond the power of anyone to make better arrangements; the transports as they stood had to be utilized to the best advantage. Not having been originally built for such service it was difficult to arrange matters so as to take such an organization as a light battery all complete upon any transport. As finally arranged, light batteries E and K. 1st Artillery, were loaded complete upon the transport *Comal*, in connection with other troops, while A and F batteries of the 2nd Artillery loaded their guns, carriages, harness and ammunition upon the transport *Iroquois*, while the men, horses and camp equipage were loaded upon the *Berkshire*.

As stated above, this could not be avoided, the *Iroquois* had deck room where the guns, etc., could be loaded, but was so built originally that she could not be arranged for horses, or at least for the number required; the *Berkshire* could take the horses, but could not take the guns, hence their separation was unavoidable; of course the *men* had to go with the horses, to care for them, etc., and the *Berkshire* furnished good accommodation for both men and horses, or as good as could be expected under the circumstances. At the last moment, almost, to relieve an overcrowded ship, two companies of infantry were transferred to the *Berkshire*, making us somewhat crowded; but yet there was nothing but what could be readily borne for the few days the trip would probably consume, and everyone settled down quite contentedly, looking forward to a comparatively pleasant trip.

The trip to Cuba was without special incident: there was no sickness of a serious nature, and no fault finding or complaint worthy of the name.

We arrived off Daiquiri, Cuba, on June 20th, but the details for unloading, etc., were not complete until June 22nd, and on that date the landing began.

General Orders No. 18, Headquarters Fifth Army Corps, dated at Sea, June 20th, 1898, gives the details for the landing as follows:

1st. The 2nd Division, 5th Corps (Lawton's). The Gatling gun detachment will accompany this division.

2nd. General Bate's Brigade. This brigade will form as a reserve to the 2nd Division, 5th Corps.

3rd. The dismounted Cavalry Division (Wheeler's).

4th. The 1st Division, 4th Corps (Kent's).

5th. The squadron of the 2nd Cavalry (Rafferty's).

6th. If the enemy, in force, vigorously resists the landing, the light artillery, or part of it, will be disembarked by the battalion commander, and brought to the assistance of the troops engaged. If no serious opposition be offered, this artillery will be unloaded after the mounted squadron.

As there was no opposition to the landing there was no necessity for the above 6th paragraph to be carried out, except as to unloading "after the mounted squadron." In fact the opportunity for unloading was not given until the 23rd and 24th, when the transports moved in closely enough, and the horses were thrown overboard and towed ashore.

After the horses were ashore, and men had been landed to look out and care for them there was a conflict of orders as to where the guns were to be unloaded. At first the report was received that the road from Daiquiri to Siboney was impassable for artillery, and that the guns, etc., would have to be unloaded at Siboney, the horses being brought overland to join at Siboney. In fact orders were given for men enough to be put ashore to lead or ride the horses to Siboney, from Daiquiri, while the rest of the men were to remain on the transport to go to Siboney, and there unload the guns, etc. In the meantime where the *Iroquois* was no one seemed to know; she was probably off unloading her complement of enlisted men, possibly at Siboney; on this point the writer must confess his ignorance, stating, however, that he had then and has had since, no means of knowing where she went to, she being beyond our control.

On the 25th, however, she came into Daiquiri, a scow was provided also, and batteries A and F soon had their guns and battery equipments on shore.

On the 26th the ammunition was unloaded, and batteries A and F straightened out their equipment, loaded and hitched up, and pulled out for Siboney; on the 27th they, with Best's battery, arrived at Seville, and on the 28th Capron's battery also came up, completing the battalion, all present at the front.

The march from Daiquiri to Seville was anything but a picnic. The batteries were loaded down with their full complement of ammunition, three days rations, and with all the hay and grain that could be loaded upon the ammunition chests. The roads were simply vile; narrow, uneven, with sharp turns and pitches, full of rocks and chuck holes and, last but not least, full of men; it was now that the bad effect of green horses and green drivers began to be felt, to say nothing of the leg weary condition of all of the stock from its confinement upon ship-board, to overcome which there had not as yet been sufficient time of rest. Understand that the artillery was not complaining, nor does it complain. It knows as well as anyone the task it had to do, and entered upon its accomplishment cheerfully and zealously; yet at the same time everyone connected therewith knew the difficulties, and appreciated the limitations within which certain work could be done, and at the same time save the stock the utmost possible.

The stock was suffering from the heat and oppression of an unusual atmosphere even more than the men. They were watered whenever and wherever practicable; at times eight and even ten horses had to be coupled up to get the carriages through; hence the march, though short in actual distance travelled, was very hard upon both horses and men.

Unlike the universally accepted idea, as believed by those *not* in the light artillery, and as pictured forth in the many beautiful but fictitious representations of light artillery, the men (cannoneers) marched on foot, each carrying his little(?) blanket-roll and rations the same as any "dough boy." There was no thought of such a thing as these cannoneers sitting up, upon the limber chests, with arms folded, and taking it easy, while the rest of the troops plodded through the mud. Each and every cannoneer had to march as I have said, and, besides this, they had to tug and strain, use pick and shovel or other tools, fixing "chuck holes" in the road, and helping stalled teams, etc., working, as well as marching, to get everything through as soon as possible.

How well, or how ill this march might have been performed with thoroughly trained horses and drivers will never be known. It is well known, however, that in many cases the green horses and green men were worse than useless, they were actually an incumbrance. One pair of awkward green horses in a team of six would often balk and render useless all the energy and effort of the other trained four; often the green horses had to be taken out and their places supplied by some of the old horses from other teams before the carriage or caisson could be budged from the chuck hole, or be pulled up a steep incline. This caused not only delay, but also made double work for many of the old horses; all of these set-backs were well understood and taken as a matter of course by all of the artillery, but were apparently little understood or appreciated by anyone else, as evidenced by the sneers and ridicule freely indulged in by troops in the road. But, as I say, the artillery made no complaint, it well knew that this was *war*, and all that it entails, and, much as it would have liked to have had a better chance, and to have made a better showing, the circumstances were beyond its control, and had to be put up with and made the best of without a murmur.

The time in camp at Seville, during the 28th, 29th and 30th of June was utilized as best it could be in resting and shoeing the horses against whatever might be in store. Again the green horse question handicapped us to a great extent; there had not been time to shoe all of these new horses before we left Port Tampa. Horseshoes had not been as plenty as huckle-berries either, and, when we went aboard ship, many of the horses were not fully shod, and they had made the march from Daiquiri partly barefoot. These horses, together with those that had cast shoes, had to be fully shod in camp at Seville, and certain it is that the artificiers had but little rest, no matter what the others may have had. And it seemed too that everyone that came along thought he could have his horse shod as a matter of course for the simple asking, or, in some cases, the impudent *demand* that was made for such accommodation. Though disposed to be obliging, and glad to do anything for either accommodation or for the public good in such a case, it yet must be conceded that the light artillery is not organized as a travelling blacksmith shop, to shoe the horses for an entire command; it has its duty to do *for itself*, and to keep itself in serviceable condition, or else run the risk of severe censure for being in unserviceable condition; hence what may at the time have appeared harsh and selfish in refusing to shoe all horses was absolutely unavoidable, and always will be unavoidable.

All the grain and hay available, and the limited grazing in and about the camp, was made the most of during the rest in camp to keep up the strength of the stock. It should be well known, but it seems to be little appreciated, that draft horses cannot do their full work upon starvation rations. True it is that war has no mercy upon either beast or man, and, hard as it may be, one has to put sympathy oneside and often work horses till they die in their harness; this does not obviate the duty of first trying all within one's power to see that the stock is properly cared for, and kept up the best possible; after that has been done, when the necessity arises, no one will be found that will not work his horses until they drop dead to accomplish the allotted task of marching or in putting guns in the best position possible for effective work.

I dwell upon this point for the reason that there is all the difference between ordinary peace drill or marching, and the actual work of war for light artillery that there always is between Romance and Reality, and, when not well understood, this difference appears to militate against the artillery in war. Those, who as onlookers, see light artillery in garrison, dashing about with empty ammunition chests, and hence no load for the teams to speak of; with cannoneers upon the boxes during rapid drill, and with all the dash and vim of rapid work, naturally and unconciously form an idea and a picture of what it should do in war, as far from the actual reality as well can be, particularly where the country is anything like that around Santiago; and when the reality is seen, the heavy drag of heavy loads upon miserable roads, the straggling cannoneers on foot, each loaded down with his own impedimenta, everything soggy, wet, muddy and bedraggled, the natural disappointment cannot but have its effect, and react against the artillery itself, and cause it to be called useless and inefficient. And yet, though the dash and vim may not be apparent, the "get there" is there all the same, and the same bedraggled and disreputable looking outfit is just as ready to go in and fight as ever, though sadly shorn of the "pomp and circumstance of war."

An incident of the march from Daiquiri, and a matter of adverse criticism of the artillery might as well be mentioned now as later, as they have a certain relation.

When light batteries A and F, 2nd Artillery, left Daiquiri each battery had filled its ammunition chests to their full capacity, and had some few extra in boxes strapped upon the foot-boards of the carriages. Yet each battery had been forced to abandon quite a large amount of ammunition upon the beach, with no one to be found to whom it could be properly turned over. A few miles out from Daiquiri the acting chief ordnance officer of the corps, an infantryman, was met, on his way back to Daiquiri. He stopped and spoke to the writer, and asked how we were off for ammunition, and appeared rejoiced—at first—when told we had our chests completely full.

Advantage was taken of this opportunity to report officially—though verbally—the abandonment of the ammunition upon the beach, above referred to, and attention was also invited to the *lasting qualities* of the amount we had with us, in case we got into a fight, with no reserve ammunition to fall back upon. A little sum in mental arithmetic soon showed this officer that the supply in our chests would last but a short time, comparatively, and, evidently much to his surprise, it would be necessary to see to it that *all* of the reserve ammunition be brought to the front at once, in order that the batteries might not find themselves with empty chests at some critical moment.

It will be remembered that each battery had *four* guns and *four* caissons. The full battery, on a war footing calls for six guns, and *nine* caissons. Hence the ammunition supply with the battery was away short of intention and requirements, and presented itself as follows:

The normal rate of fire as laid down is six shots every two minutes. (See Par. 186, Artillery Drill Regulations, edition 1891). At this rate the ammunition of a four-gun, four-caisson battery will be consumed as follows: Each gun-limber has one chest; each caisson with limber has three chests, or four chests per gun, or sixteen chests for such a battery; each chest holds forty-two rounds, or a total of six hundred and seventy-two rounds for the battery. At three shots per minute we will then use up this amount in two hundred and twenty-four minutes, or in three hours forty-four minutes the chests will be completely empty, and a fresh supply must be at hand if the battery is to be anything more than a spectator for the rest of the engagement.

Comment and criticism have been lavish and bitter as well as unjust as to the slowness of fire of Capron's battery at El Caney. Let us look at this a moment in the light of the above.

"The battery" "opened fire under personal orders of the Major-General in command, about 6:15 o'clock a. m., and continued its fire against specified objectives intermittently throughout the day *under the personal direction of the division commander.*" (These italics are ours).

Here we then have a battery in action for five hours and fifteen minutes in the morning, and for one hour and forty minutes in the afternoon, or a total of six hours and fifty-five minutes. It was off by itself, beyond reach of any ammunition supply, and had the fire been maintained steadily at the normal rate its ammunition must have been exhausted within one minute of 10 o'clock a. m. Is any comment needed as to *why* the fire was slow, leaving out of the question all consideration of the element of "personal direction?"

With a six-gun, six-caisson battery the ammunition would be one thousand and eight rounds, lasting five hours and thirty-six minutes, at normal rate of fire; a six-gun, nine-caisson battery would carry thirteen hundred and eighty-six rounds. and would have empty chests after seven hours and forty-two minutes steady normal fire.

Much as some of the light artillery might like to try and come up to the shining ideal of some of our infantry friends, and go in with a rush and dash, and indulge is a slam bang, hip hurrah! roar and rattle of a bombardment, it is seen that it is simply impossible from the limitation of the ammunition supply, to say nothing of the necessity for fire control and discipline to *observe the effect of the fire*, and, by such observation, to correct for range and thereby make the fire *effective*. If a *noise* only is wanted, blank cartridges would seem to be all that are required, much to the lightening of our loads, for blank cartridges would be fully as *noisy*, and produce as much effect, as rapid, careless, poorly aimed, and unobserved fire of the best of projectiles, fired from the best of guns. We are here again confronted with the difference between the ideal and the actual, between romance and reality, and the light artillery has unjustly suffered from the contrast.

It may be permitted to pause here a moment and consider this subject of rate of fire as viewed professionally by some of the authorities upon the subject.

It is of course assumed without comment that the rate of fire adopted by the board which formulated the artillery drill regulations was in accordance with the concensus of opinion of the best authorities, domestic or foreign, that was to be obtained. And that this opinion has not changed much since 1891 may be shown by the following quotation:

"We are of the opinion, expressed here on previous occasions, that quiet and well conducted fire should always be employed, because it leads the most quickly to the desired end, with the least expenditure of ammunition. *Certainty* in ranging, and afterwards, well-aimed, observed, and well sustained (not rapid) fire is certain of its success. The effect of fire is so great, that, if ranging is properly carried out, a few projectiles will secure the destruction of the object aimed at; rapid fire then is superfluous. But if the ranging be not properly done, rapid fire is pernicious, for it consumes the greatest amount of ammunition in the shortest possible time. Rapid and dependable ranging is of much greater value than rapid fire after the ranging has been completed."

(See Infantry, Cavalry and Artillery Tactics. Von Löbell's annual reports. From the *Royal United Service Institution.* Reprinted November, 1898, *Journal M. S. I.*, p. 484).

Other authorities, equally as positive and as reliable, could be quoted by the dozen in support of this point; but such cumulation of evidence is not considered as necessary.

Another element which contributes to the slowness of fire under certain conditions is the presence of the smoke of the guns firing black powder. If a strong wind is blowing in the right direction the effect of the smoke hiding the objective is but slight; but with no wind, and a heavy atmosphere, the pall of smoke often shuts out the objective for minutes at a time, and prevents proper observation and aiming to make corrections in picking up, and maintaining the range and effective fire.

Judging by what has been said it would seem to be the prevailing idea that the Ordnance Department and the artillery had been indulging in a Rip Van Winkleian nap during the many years of peace, and had all at once awakened with a war on its hands, and with no suitable provision of or attempt at providing a smokeless powder with which to meet its emergencies. This is known to be not only a mistaken, but a very unjust idea, for it is known that experiment and research have been going on for years to develop a *certain* and *safe* smokeless powder, one that will be constant, or approximately so, in its action, one that will be reliable not only to-day, but after long years of storage; the recent bursting of a 10-inch B. L. rifle at Sandy Hook, firing smokeless powder, will tell whether the effort has or has not been crowned with success.

Smokeless powder for small arms has long been an accomplished fact, within certain limiting chances of uncertain action even with it after years of storage. But smokeless powder for guns of large caliber is another matter, particularly those that were built at first for black, or brown, powder charges, and have therefore certain chamber capacities that must be considered in all adaptation of powder charges to them. We had to use black powder in our field guns, not because we wanted to, not because the desirability for smokeless powder was not fully understood and appreciated by those having the matter in charge, but because, as in many other matters, this war came upon us with experiments yet in progress and yet uncompleted and undetermined, with matters in a state of transition, and not fully crystallized into a certain and sure system based upon a certain and sure smokeless powder.

To show the prevailing and unjust idea that prevailed at Santiago, the following is inserted:

"Our artillery made one or two efforts to come into action on the firing line of the infantry, but the black powder rendered each attempt fruitless. The Spanish guns used smokeless powder, so that it was difficult to place them. In this respect they were on a par with their own infantry and with our regular infantry and dismounted cavalry; but our only two volunteer infantry regiments, the Second Massachusetts and the Seventy-first New York, and our artillery, all had black powder. This rendered the two volunteer regiments, which were armed with the antiquated Springfield, almost uselees in the battle, and did practically the same thing for the artillery wherever it was formed within rifle range. When one of the guns was discharged a thick cloud of smoke shot out and hung over the place, making an ideal target, and in half a minute every Spanish gun and rifle within range was directed at the particular spot thus indicated; the consequence was that after a more or less lengthy stand the gun was silenced or driven off. We got no appreciable help from our guns on July 1st. Our men were quick to realize the defects of our artillery, but they were entirely philosophic about it not showing the least concern at its failure. On the contrary, whenever they heard our artillery open they would grin as they looked at one another and remark, 'There go the guns again; wonder how soon they'll be shut up,' and shut up they were sure to be. The light battery of Hotchkiss one-pounders, under Lieutenant J. B. Hughes, of the Tenth Cavalry, was handled with conspicuous gallantry.—The Rough Riders, by Theodore Roosevelt, Colonel of the First United States Volunteer Cavalry. The cavalry at Santiago." *Scribner's Magazine*, April, 1899. p. 435.

Paranthetically we will remark that everything but the poor(?) inefficient(?) artillery was handled with "conspicuous gallantry;" no one has a good word to say for this "highly over-rated arm of the service."

Now, like everything else, there are two sides to this story. Let us look at the other side for a moment, still considering black *versus* smokeless powder.

1st. It may be asserted that, beyond any peradventure of doubt, the discovery and adoption of smokeless powder was the result of one of those accidents so frequently encountered in the change of the material of armies. Smokeless powder *per se* was not being sought at first, though it may have been in the minds of some few military men at the time. *A new and small bored rifle was being sought in order to lighten the cartridge in use, and thus make it possible to increase the number that each soldier could carry, this being one possible solution of the ever present problem as to supply of ammunition upon the battlefield.* At first the experiments with these small caliber rifles were conducted with *black* powder, and it was soon discovered that this would not answer, owing to fouling of the bore, irregular shooting as a result, together with the rapid deformation of the bore from the fouling, nor could the necessary velocities called for to keep the long, thin projectile in its true flight be obtained with *black* powder. Hence the imperative necessity for some other form of explosive to make the small calibred rifle a success. Experiments with high explosives showed *first* the absence comparatively of residuum; *second* the necessary velocities; and *third and last in importance its smokeless character.* That is the genesis of smokeless powder in small arms; this third condition was soon recognized as being of the utmost importance; but at first it was *not* being deliberately sought for, no matter what the ordinary accepted idea may be.

2nd. As soon as the *advantages* of smokeless powder began to be seen, its *disadvantages* were also fully recognized, and they have been most freely and fully discussed; upon these advantages and disadvantages the following quotations will perhaps throw some light:

"The absence of smoke from the field of battle cannot change any principle of tactics, since it is but a covering or screen, differing from that given by natural objects only in the fact that it is impossible to avoid it when it becomes hurtful. This absence of smoke emphasizes the principle of 'seeing and not being seen;' since it renders the realization more possible. *Smoke gives cover for maneuvers, and so lessens losses* (the italics are ours); it makes feasible the replenishing of ammunition, and even sometimes by concealing losses, sustains the morale of the troops.

"The meaning of all this is that morale plays a great part upon battlefields, and that all tactics must take it into consideration. It is claimed that the absence of smoke will allow troops to see comrades fall and their commanders taken away, and hence will lower their morale. On the other hand it cannot be doubted that if smokeless powder be employed by all arms of the service that the field will be cleared for skillful action. * * *"

Speaking on this subject of smokeless powders in their application for light artillery service:

"The battery is a better target than formerly, but as it is in more danger when coming into action than after it opens fire, and as it makes no smoke before firing, the advantage of smoke as a covering disappears, especially so when considered in connection with its subsequent blinding effect upon the gunners.

"Being a better target, artillery must now doubtless endeavor to obtain all shelter compatible with its efficiency in firing. This means a more intelligent reconnaissance of the whole field, especially as to all possible artillery positions. Batteries must not run the risk, unnecessarily, of coming into action at points exposed to fire, possibly from unseen guns or skirmishers.

"Absence of smoke will enable a battery to take a covered position and fire away for some time without its position being discovered.

"Without smoke we shall not, as at Sadowa, hear of infantry advancing, unseen, to such short range that the artillery, unable to defend itself, is captured." (See "Small Arms and Ammunition," Colonel J. P. Farley, O. D. January *Journal M. S. I.*, Pp. 49-50).

Further quotations by the yard could be indulged in to show relative advantages and disadvantages of smokeless powder. Lieutenant (now Captain) H. C. Davis' article, "Battle under new Conditions," freely quoted above by Colonel Farley, and contained in September, 1898, *Journal M. S. I.*, P. 249, *et seq.*, could be quoted as an whole upon this subject; but again there is no advantage to be gained by the accumulation of evidence.

During this rather long digression the artillery battalion has been resting in camp at Seville, from June 28th to 30th inclusive; let us now resume the incidents of the campaign.

Muster took place in camp at Seville, and on the 30th at 7 a. m., Captain Grimes was ordered to report to General Shafter, and a little later accompanied him to El Poso hill, which "on a ridge near by" he "was directed to prepare and occupy with" his "battery on the following day." The battery was brought to El Poso on the afternoon of the 30th, arriving about 4 p. m.

In the meantime Captain Capron had reported to General Lawton, and "left camp near Sevilla 3:30 p. m. and took position near El Caney 8:30 p. m. to fire on El Caney the next day."

During the evening of June 30th orders were received for Best's and Parkhurst's batteries to be ready to pull out at a moments notice in the morning. "At about 7 a. m. orders were received to proceed to and report at General Shafters headquarters at the front. This order was complied with, and my battery, in company with battery K, First Artillery (Captain Best's), was parked just off the road near those headquarters, and were there held in reserve for some hours, the exact time not taken."

On arriving at General Shafter's headquarters, and just as we halted in the road to make the report called for by our orders, an order was delivered from Colonel McClernand directing Major Dillenback to proceed to the front at once, *with the two batteries*, to take position. As here was an apparent conflict of orders. and as we were then right at General Shafter's headquarters, the original order was complied with, with the result that the two batteries were held in reserve, and parked off the road at these headquarters as above stated.

No inviduous comment is intended, for doubtless General Shafter had not only the right, but the apparent necessity for holding these two batteries in reserve as he did; he had two battles practically upon his hands, and could not then tell which might most need assistance, or re-inforcement by artillery; we were held in reserve at the nearest dividing point, at the "forks in the road," as might be said, ready to be sent where most needed.

We well know it is not for us to criticise; but, with the proverbial "hind sight" as an aid to our ideas, may it not be questioned whether these two batteries should not have been sent on as keen a "jump" as the condition of the roads would permit to the assistance of the attack upon Caney? Here, as events proved, was the heavy fighting of the day. Here from 6:15 a. m. till 4:30 p. m. a battle was raging, supported only by one little battery of four guns. Here was a stone fort, a stone church, blockhouses, and innumerable trenches, some of them cut in the solid rock. Here was the most stubborn resistence of our enemy, and the most intrepid gallantry of our forces, storming and carrying this village in spite of all opposition, and in spite of *utterly inadequate artillery support.* But can the artillery be held responsible for this? Could it pick and choose and formulate its own orders? Was there artillery enough to go around? Here we see the effect of the limited supply of guns. And yet, as appears in the beginning of this article, how was this to be remedied? We had all the transports could carry; thousands of men, and hundreds of horses were left back at Port Tampa and vicinity for want of transports. *Time was an element of the greatest importance in the sailing of the expedition. It had to go*, weak as it was in artillery, without any chance to add to its strength, in order to "get there" and do something at once. The success of the expedition should have made us all thank God, and congratulate each other for this success, and should have prevented all the later crimination and recrimination; should have made us all willing to give due credit to all efforts towards that success just as due credit is gladly and heartily given by the artillery for everything done by all the other arms of the service.

But this order to go to Caney was not to be, and we must consider the orders as given.

If the second order had been carried out as it was understood, Best's and Parkhurst's batteries would evidently have been in position alongside of Grimes early in the forenoon, and would have added their power to his guns in the bombardment of San Juan Hill, the blockhouse, trenches, etc., and then perhaps there would have been a different story, with less of adverse criticism as to what the artillery accomplished, or failed to accomplish. This too, though it may well be questioned if the "artillery duel" opened up by Grimes' battery at 8 a. m. was not somewhat premature. Here too was but one battery of four guns placed in the unique position of being *all* of the artillery in position to open up an artillery duel against an enemy whose strength in artillery was absolutely unknown. Here too were masses of dismounted troops huddled and bunched in and about the vicinity of this battery, in just the very place where *not* wanted or needed, sure to be punished by any return artillery fire from the enemy. No troops were up at the front, or, if any, in not sufficient numbers to take advantage of any success from the artillery duel. The deployment against San Juan hill did not take shape till hours after 8 a. m. No wonder then that "the enemy," though he "could be seen running away from the vicinity of the blockhouse," * * * came back again when the bombardment * * * was over." We will soon show *why* this bombardment ceased. Just at this time events have proved that one battery, or *no battery* would have done all of the work required. Later on, when our troops finally were about in position, all these batteries could have done effective work, and this work they *did do*, as will be presently shown. Hence "what might have been" is all pure speculation, orders were received, and were obeyed. How could it have been otherwise? How could these two batteries have done differently, have taken the initiative, and gone rushing into battle without orders, as some flippant commentators seem to have thought they might?

While in reserve the battle at El Caney and San Juan could be distinctly heard, but nothing could be told except a wild guess as to what was actually transpiring.

While thus held in reserve the battalion commander was absent at the front looking for position for the guns. His report is silent upon the point of being held in reserve; it merely states that "on the morning of July 1st I was ordered to take the two remaining batteries to the front and assist Grimes' battery that was engaged at El Poso in shelling the enemy's works, and was under a hot fire from the enemy's guns. The enemy used smokeless powder, and the position of the guns was hard to locate. I placed Best's and Parkhurst's batteries on Grimes' left, and after a vigorous shelling of the enemy's works on the ridge by all three batteries, the position was occupied by our infantry."

Captain Best's report is silent as to having been held in reserve, he states: On July 1st, about 2 p. m., the battery took station on the ridge just to the left of light battery A, 2nd Artillery, and opened fire on Fort Canosa and trench in front. In a few moments our troops were in possession of these points and firing by the battery ceased.

Lieutenant Aultman's report is also silent about having been held in reserve, he states: "We took position on the left of light battery A, 2nd Artillery, Captain G. S. Grimes commanding, on the hill above El Poso, and opened fire on the trenches and blockhouse of San Juan. Four shots were fired by the battery, when the United States forces were observed going up the hill, on which the blockhouse was situated, and the order was given to cease firing."

General Shafter says: During the afternoon, Major Dillenback, by my order, brought forward the two remaining batteries of his battalion, and put them in position at El Poso, to the left of Grimes."

It thus becomes apparent that these two batteries, Best's and Parkhurst's, were held in reserve as stated, and furthermore it becomes apparent that Grimes' battery was *not* the only battery brought into action, as is stated in the extracts forming the text of this article.

Unfortunately the *exact time* when Best's and Parkhurst's batteries were moved to the front and went into position was not taken. A careful study of *all* of the reports of those interested shows a general mix up as to the *exact* time San Juan Hill was taken; it variously appears to have been anywhere from "about noon" to "about 2 p. m."

On the arrival of Best's and Parkhurst's batteries at El Poso Hill, Best leading, it was observed that Grimes' battery was not then in action, but was busy replenishing the gun-limber chests with ammunition, or making an exchange of gun-limbers for caisson-limbers, the caissons being down at the foot of the hill.

Upon this point Captain Grimes' report states: "About 160 projectiles were fired during the fight; " this would just about empty the four gun limbers, their actual contents being 168 rounds.

It may not be impertinent to here remark, in connection with the quotation from the *Scribner Magazine*, that Grimes' battery at no time was compelled to "Shut up" because of any return fire, either from shrapnel or small arms. Ceased firing it may have frequently; *first because "the artillery duel" engaged in was premature, there being no one up near the hill to take advantage of "the enemy"* * * * *"running away from the vicinity of the block house,"* as quoted in the extract from *Munsey's*, forming part of the text at the head of this article; and second, because, as Captain Grimes reports, "the balloon, which ascended between the lines, and close to our line of fire on the blockhouse, attracted the firing of the Spanish guns, and prevented me from returning it until the balloon descended. * * *

The battery was at no time under small-arm fire."

As soon as the two batteries were in position, and while some brush was being cut away from in front of Parkhurst's guns to permit of clear aiming, the enemy's position was carefully studied with field glasses.

Directly in our front was San Juan Hill, with its blockhouse and a long trench coming down the slope of the hill lirectly towards our position; our guns enfiladed this long trench exactly; at its lower end, at the top of quite a high, steep, bluff-like elevation, appeared to be some trenches perpendicular to the main trench, and also to our line of fire. Our infantry line could be seen in the form of a large semi-circle, in the open field at the foot of this bluff, and the general slope of the hill, evidently engaging the Spanish blockhouse and trenches, from which a heavy and rapid fire of small arms could plainly be seen; no artillery fire could be detected.

This was all seen in less time than it takes to tell it, and immediately the guns were loaded and laid at these trenches and the blockhouse for an objective. The range was passed on down to the writer by Lieutenant Lassiter, as 2,425 yards, and we waited Best's first shot to see how it held up. It was seen to strike and explode in the trench, near the top of the bluff, and orders were at once given for an elevation of 2,450 yards for Parkhurst's first gun; this shell also struck and exploded in the long trench; 2,475 was the elevation for the next gun; this shell struck and exploded in the long trench ; 2,500 was for the third gun ; this shell hit the blockhouse, as was shown by the roofing tiles and dust that were thrown in the air ; the fourth shot was also at 2,500 yards, and also hit the blockhouse.

In the meantime Best's battery had landed three more shell, all just where he wanted them, and the one round of the two batteries was done.

The range of the objective was now determined beyond a doubt, and the batteries could have pounded the blockhouse and and trenches by the hour thereafter, had they not been prevented, as will now appear.

Entering within the pall of smoke to see the guns loaded for the next round the writer was thereby shut off from any view of the San Juan Hill, and moreover his attention was concentrated upon the loading ; hence he saw nothing of what was happening at the front.

But, to his great surprise, the signal "cease firing" was passed ; running out of the smoke it was then seen at a glance, and without glasses, that "the thin blue line" had swept on up the hill, and was swarming over the trenches, and up to and around the blockhouse ; of course further fire was neither needed, nor was possible against that objective.

It is possible, and in fact probable, that this "thin blue line" had begun its advance at about the time these two batteries opened up their fire ; the first glance through the glasses, studying the objective, etc., as above set forth showed the line at the foot of the hill as stated. When the firing began there was no time to be watching anything else except the effect of the fire, and to see that nothing appeared in the line of the objective that could be damaged by our fire, except that which we were trying to damage all in our power ; and then too it was known that our line was being observed, so as to stop the fire the moment it became necessary ; hence, though not actually seen by the writer, he is convinced that not a shot was fired that could by any possibility have damaged any of our own men ; remember we were firing *percussion shell*, that burst only on impact, and *not* shrapnel that burst on a time fuze in the air ; hence there were no high bursts, and no fragments to possibly scatter over, or among our own advancing men.

And again, even had we been using shrapnel, it must be remembered that THEY *never* burst *backwards ;* a shrapnel, bursting directly over one's head, and at the usual height above ground will never harm anyone. If the writer could be assured that he would live until killed by such a burst, he would rival the Wandering Jew for age, even though fired at every day, for the fragments *all go forward*, the remaining velocity of the fragments being such that not one in a million would ever drop vertically downwards, or be blown backwards.

Neither the writer, nor the artillery, have any desire to claim anything not justly theirs in any of the engagements in front of Santiago. But who can say that the eight shots fired as above described were not fired just at that peculiar crisis in an engagement that needs but a little either one way or the other to determine a victory, or cause a defeat? It is claimed at least that the artillery did all that it was allowed to do, even though not all that it would have liked to have done, and, even though "the field artillery played no great part in the battle" it was because it, as well as others, had to obey orders, and was not permitted to do more than has been set forth.

And amidst all the hell of shot and shell, small arms fire, BULLETS from Gatling guns, and the fire from the Hotchkiss battery, which was the most likely to prove a determining factor: whether to HUG THE TRENCHES, or to get up and run while life was left? With an expressed desire not to belittle or disparage anything; with the desire most heartily felt to give credit and praise to *all*, the effort being made to dislodge the enemy from whatsoever quarter it came, it still must be conceeded *that all the fire except that of the artillery was being* thrown UP hill, and none of it enfiladed or had the same plunging fire upon either trenches or blockhouse that this shell fire of the artillery did have; it must be conceeded that such fire UP HILL could not and did not search out the enemy behind his cover, and could only do him injury when his head was up above the surface of the ground. In other words all this fire except that of the artillery would tend to make him HUG his trenches, and not to get up and run, and thereby expose himself to the fire, from which the trenches gave him shelter.

And again, did not the enemy know from whence this shell fire was coming? Could he not see, had he not seen the artillery line extended to three times its original extent? Did he not know that there were plenty more shells ready to come from where these eight well aimed projectiles had come, and that he could do nothing to prevent? To hug the trenches was but to die; to get up and run afforded a chance to live; hence get up and run he did, leaving the last opposition to the infantry advance but slight and feeble, no matter how stubborn it had at first been.

It is claimed therefore that, in spite of the fact that but eight shots were fired at this time, these eight shots were deadly, that they did strike *not only near* but IN the San Juan blockhouse, that they did explode near it, and in the trenches, that they were a great determining factor in the flight of the Spaniards. While upon this point it may be permitted to quote from the official reports of those immediately interested in the actual assault.

From the report of Captain Levin C. Allen, 16th infantry, we gather the following extracts: "The advance continued steadily and without a pause until we were on the steep slope near the crest, two-thirds of the way up, when our artillery fire, coming from the rear, became dangerous. I was not disposed to stop for this, because I thought the fire would cease in time. Some shells struck the slope between me and the crest, but I urged my men forward, and they responded nobly. We had seen the enemy leave their trenches, and I was anxious to press home our victory. But at this time there arose at the foot of the slope and in the field behind us a great cry of "Come back," "Come back." The trumpets then sounded "Cease firing," "Recall," and "Assembly." The men hesitated, stopped, and began drifting back down the steep slope. The enemy having been ousted and on the run, there was nothing to interrupt our advance save the loud mouths of those in rear who became suddenly fearful for our safety.

"Precious time was lost. As for myself and company we reluctantly drifted back downwards about 20 yards, and I hurled at the wretches below all the oaths I have learned in thirty years life in the army. I ordered the men to lie down and get their breath, which they did. Just then I noticed Captain McFarland with some of his men still on the slope on our original front line. He was waving his hat. I took it to be a call for support. He was about 20 yards to my right. I called out 'Look at Captain McFarland and E company,' 'Who of C company will go with me to the top of that hill in spite of hell and the battery?' I hoped we might yet break over the unfortunate check. The men near me sprang to their feet, and we plunged up the hill once more, only to find Captain McFarland wounded, and his men coming slowly back. The cry of 'Come back!' once more filled the air. My following became too small to advance further, and once more I fell back towards my over anxious friends below. I believed then, and I believe now, that if those in rear had kept their mouths shut, we five captains could and would have led our men straight to the crest, and that the battery would have ceased firing as soon as we would have occupied the works, and that the victory so dearly won would have been more fruitful. When the battery ceased we again went up. The Sixteenth Infantry colors passed to the crest and were planted there." * * *

(See page 281. Report of the Major-General commanding the army, 1898).

It has been stated and claimed that Captain McFarland was wounded by the artillery fire. Upon this point it will be remembered that no *shrapnel* was being thrown, and further I quote from Captain McFarland as follows: "Captain Noble was the only officer I saw on the slope of the hill before I was shot, and I believe his signal to our battery caused it to cease firing." (Page 280, Report of Major-General Commanding the Army, 1898).

* * * * *

Again: "When lying in the sunken road, the blockhouse and trenches, called the 'San Juan Fort' was immediately in our front, on a hill some 150 to 200 feet high, and about 700 yards distant, an open and level field lying between the ascent of this hill, which is very abrupt, and the sunken road. * * * The fire from the hill being very destructive, it became apparent that the enemy's works in our front must be taken, or our army forced to retreat. * * * The first men having been followed by others into the field, an assault was ordered; the line rose in the road, broke and beat down the fence, and followed across the field, neither halting nor lying down to fire. When this main line reached the foot of the hill (many attached men were on the slope, some even at the crest in close proximity to the Spanish trenches), a momentary hesitation was caused, I presume by the fire of one of our own batteries, which did not cease when our men were in the position above spoken of. After this momentary hesitation, the main line advanced up the hill."

* * * * *

(See page 303, Report of Major-General Commanding the Army, 1898).

It will be noted that though Captain McFarland speaks of having been shot, he does not either in what is quoted, or in any of the rest of the report, speak of having been shot by artillery fire.

Lieutenant R. R. Steedman, 16th Infantry, reports as follows: * * * "Our lines were scattered somewhat in moving forward, owing to distance passed over, steepness of slope, and the enemy's fire. Our foremost men were delayed a few moments near the crest of the hill from the artillery fire and from misunderstanding of the orders sent us, but continued the assault, and were among the first to gain the top directly in front of this trench, so that as we gained the crest many of our men had to step over this trench filled with dead and wounded."

* * * * *

(See page 282, Report of Major-General Commanding the Army, 1898).

Captain L. W. V. Kennon, 6th Infantry, says:

* * * * *

"Our artillery fire having ceased, Company E went up the hill, and was the first organization of our army to reach the summit and the fort. A number of enlisted men of other companies joined in the advance, and reached the crest with us. At this time there were a few Spaniards in the blockhouse, and in the trenches to the flanks, but the greater part were in rear of the first, retreating to a position in rear. * * *

(See page 288, Report of Major-General Commanding the Army, 1898).

Many more quotations could be made, all to the safe effect, viz: that the artillery was firing just before, and during the charge that captured San Juan hill, blockhouse and trenches, but it is not necessary to accumulate evidence.

If, as it would seem from the evidence quoted, the infantry was nervous at being shot over by the artillery, let us see from a few extracts what was the effect upon them of other firing.

Captain S. R. Whitall, 16th Infantry, reports:

* * * "At this time the battery of four Gatling guns began to fire from the bluff we had just left, directly over our heads, and as we were about on a level with these guns, they made it rather uncomfortable for the few minutes I stayed there, firing directly over the right of my company." * * *

(See page 285, Report of Major-General Commanding the Army, 1898).

Lieutenant D. W. Ryther reports:

"We thought, while lying near the fence, that E Company, to our right and rear, were firing too closely to us, but upon asking Captain Kennon, in command, he replied that his men were not firing at all, but that it was a Gatling gun farther to the rear."

(See page 298, Report of Major-General Commanding the Army, 1898).

Lieutenant H. J. Ferguson reports:

"Our Gatling guns began playing upon the blockhouse, so we kept down the crest for some minutes. After going up to the top, as soon as the Gatling gun ceased firing, the company was assembled." * * *

(See page 426, Report of Major-General Commanding the Army, 1898).

These extracts are quite sufficient to show that the light artillery alone did not cause all the delay and nervousness due to fire from the rear, and over the advancing troops.

While the San Juan hill and trenches were being finally carried, the light batteries upon the El Poso hill were necessarily idle, and the final crowning of the hill, the assembling and reorganizing, etc., of the infantry could plainly be seen.

Orders were soon received for Best's battery to proceed to the front, and it limbered up and proceeded as rapidly as possible, and soon was in position upon San Juan hill, to the right of the blockhouse.

Referring back for a moment it is assumed that the quotation from the *Scribner Magazine* refers to this "effort" of Captain C. L. Best, with his battery to take position upon San Juan hill, on the afternoon of July 1st, as this was the *only* effort "to come into action on the firing line of the infantry," upon that day. This "effort" was made "by order." Even though he knew "Some one had blundered," it was for him "not to reason why" but to try and execute the order, and he did it gallantly and well. Here he violated principles laid down, that he was perfectly cognizant of, "not' to "run the risk, unnecessarily, of coming into action at points exposed to fire, possibly from unseen guns or skirmishers." Here he went into action without any possibility of cover, when the infantry line was forced to seek cover by lying down, and all other available means. Here, *had he not been using black powder*, he might have been annihilated, for he formed a conspicuous target on top of a hill within not to exceed 800 yards as the extreme distance of his enemy, and *the only cover he had was his own smoke, which did not add to the conspicuousness of his battery as a target, but on the contrary shut out a distinct view of his guns, men, and horses, so that they could not be fired at individually, but only collectively*, for "general results;" to this fact alone can be attributed his comparatively small losses. Here, too, he soon saw he was of no use, and that there was no "necessity" for his remaining, as shown by his report; from conversation with the writer, it is known that he could not distinguish friend from foe in the fight going on in his front; had he fired indiscriminately he might have been a cause of death to many of our own men; he could not pick up the range to the battery that opened fire upon him, *which had heretofore been inactive and which his presence and fire alone brought into action*; and he therefore, with good judgment retired, and took a position from which he could have been of use had the enemy succeeded in recapturing the San Juan hill. As soon as he retired the fire of the Spanish battery ceased also, and the infantry thus escaped any possibility of further punishment from its fire.

Grimes' and Parkhurst's batteries were held on El Poso hill, with orders to prepare for the night. While this was being done the action of Best's battery on San Juan hill could be seen, as well as the reply from the Spanish battery that opened upon him, and whose guns used *black* powder, as shown by the smoke.

Had it not been for intervening Red Cross flags this fire from the Spanish battery could have been replied to from the top of El Poso hill; but at least half a dozen Red Cross flags were covering the position of this battery; hence, without positive orders, nothing could be done in the way of reply.

Again the engagement of our infantry with the Spaniards from their second line of trenches could have been assisted from El Poso hill fully as well as, if not better, than from any position on the infantry line on San Juan hill. The range to the San Juan blockhouse was known to a certainty, and throwing either shell or shrapnel, with a range from 300 to 500 yards greater would have been as safe to our infantry as absolute inaction on our part. But there was no one to give orders, or to see what could be done, hence nothing of this nature was attempted.

Shortly after the departure of Best's battery, an order was received for Parkhurst's battery to go to the front and go into action with Best. The battery limbered up and went, but before arriving at their position another order was received to turn off to the right, and to go into position upon the "Kettle Hill," in rear of San Juan hill. Here Best's battery was formed in position, and here the other battery was formed on his left.

Both batteries were forced to keep out of action from the nature of the position. Immediately in our front, and but about 600 yards away, was the infantry upon the San Juan hill, carrying on an intermittent engagement with the enemy, who appeared to be making an effort to recapture the hill. As San Juan hill was higher than our position, and the distance so short, no fire could be maintained by our guns without great danger to our own troops; there was nothing known as to how far away the enemy might be, hence no possible knowledge as to the range required, and our guns have too flat a trajectory for any curved fire at any such short ranges as would probably have been called for. Hence all that could be done was to wait, in inaction, to support any possible retreat by our own line, and help repulse any attack by the enemy, should he gain the top of San Juan hill.

It was now getting late in the afternoon, and the spasmodic attack and fire of the enemy gradually dwindled down and ceased, and the day's battle was practically over.

Best's and Parkhurst's batteries therefore finished digging gun pits for their guns, against any possible need for them, fed the horses and men, and went into bivouac for the night.

During the night an order was received by the battalion commander, notifying him that Grimes' battery had been ordered up from El Poso hill, and directing him to "place the three batteries in position to bombard Santiago at daylight in the morning."

This order meant but one thing, and that was for the batteries to go into position *at the front*, near where two of them then were. After a consultation with Generals Wheeler, Kent and Sumner, at General Wheeler's headquarters, near San Juan hill, and after an officer had been sent back to General Shafter to explain the situation and for further instructions, the three batteries were finally located upon San Juan hill, to the left of the sunken road, and away to the right of the blockhouse.

Here gun pits were dug, beginning at first for all three batteries, about 50 to 75 feet in rear of the crest, along which was the rifle pit thrown up by our line during the night. Later Captain Grimes advanced his guns, and dug his gun pits in this infantry rifle pit.

Dawn was just about breaking, and the gun pits were getting fairly into shape, but not yet finished, when all at once, *before any gun had been fired by us*, a furious fusilade opened up in our front, and a torrent of lead began streaming over our heads.

We had been told that our front and right were protected by infantry outposts, and by a line eschelloned to our right front; but this at once appeared to have been an error; for no outposts replied to this fire, or were seen to come in, and Lawton's division, that had been expected to come up upon our right front had failed to appear.

All these batteries opened up at once with a rapid fire of shrapnel and canister, and maintained this fire until ordered withdrawn. In the meantime the infantry, or dismounted cavalry, or a mixture of both, that were bivouacked in our rear came rushing to our support, and lay down in rear of the batteries.

As the infantry rifle pits were in front of our guns, and only a short distance away, they were absolutely untenable by anyone, so long as our guns kept up their fire. The writer knows of this line lying behind him, almost under foot, but necessarily without firing.

As the guns had been put in position "to bombard Santiago at daylight in the morning" their position, back from the crest of the hill, though just what was wanted, and favorable for this bombardment, was such that they could *not* sweep the ground in their front. It is doubtful therefore if our fire proved anyways effective against the enemy. We made *noise* and *smoke* enough, and the latter was a good target for the concentration of all of the Spanish fire. At the same time this pall of smoke prevented our either seeing *or being seen* individually at least, and to this fact may perhaps be attributed the very small losses sustained.

The batteries were finally ordered withdrawn, and executed the order; not after having "fired four rounds," and then "with more haste than dignity" as it has been made to appear in the text at the head of this article, for one version; nor, as it appears elsewhere, is it true that "the artillery, having had hours to dig gun pits, fired three rounds, and was then forced to seek safety in precipitate and disorderly flight." The *facts* are far different, for Parkhurst's battery alone fired *over* 80 rounds, as was shown by the count of ammunition called for to fill the limber chests after arriving at the El Poso hill; how many the other batteries fired is unknown, and the reports of their captains fail to tell.

As above stated *they were ordered withdrawn*, and executed the order, quietly and orderly, *but by hand* down the hill, to thus save horses. In moving by hand a gun or a limber broke loose from its gun crew and ran away down hill; and that was *all the excuse there ever was* for the fairy tale about "more haste than dignity," or "precipitate and disorderly flight."

That this withdrawal was a mistake no one will attempt to deny that knows anything about the circumstances. *Why* it was done is unknown; that the batteries were not suffering badly the casualties fully substantiate; that they could have "lived" where they were is beyond all question; whether they were doing any good, and whether the risk was well worth taking of keeping them there, is another question, and one the writer will not attempt to decide.

If he may be allowed to express an opinion the mistake was in the original order sending the three batteries up to the advanced line before it was known whether Lawton's division could accomplish its task or not. The bombardment of Santiago could really have been done as well from El Poso hill as from San Juan hill, *as a beginning, or as a demonstration*, which this was evidently intended to be. For Santiago could plainly be seen, and could have been reached from El Poso, not so powerfully, of course, but still with battering power, and, as events turned favorably as a result of such demonstration, more advanced positions could have been taken as was finally the case.

Much has been said (of an inviduous nature) not only as to the inefficiency, but also as to the weakness of the light artillery in this engagement, and that of Caney.

As has already been set forth, the number of batteries and of guns that could be taken from Port Tampa was a matter of transport accommodation, concerning which the artillery most certainly had no control. Nor was it consulted; hence certainly the artillery cannot be blamed because more batteries, or more guns were not originally taken.

Whether the best use possible was made of what was at hand on July 1st is a matter for others to decide. The country was very difficult; artillery positions were not as thick as they might have been, and the one position on El Poso hill was not as extensive as it might have been. Doubtless more artillery would have been put there on June 30th if it had been at hand, and doubtless more than one battery would have been sent to El Caney had there been a plenty to spare; but as to this, other jungment than that of the artillery determined our duties and orders, and we had but to obey, and having obeyed our responsibility ceases, and blame should not attach for matters entirely beyond our control.

The proverbial "hind sight" now not only shows us, but doubtless many others, how differently many things might have been done. But postmortem engagements do not help *what has been* no matter how much we may profit by them for future operations; further discussion of this subject of the amount of artillery present is therefore dropped.

As the writer was wounded and incapacitated for further duty on the morning of July 2nd, and was immediately sent out of the country, all further narration and discussion will have to be from official reports alone, no observation of events having been possible.

The afternoon of July 2nd found all four of the light batteries upon El Poso hill. Capron's battery, coming around with Lawton's division from El Caney, was halted and sent to join the other batteries, thus once more placing the battalion all together.

The statement, set forth in the text at the head of this article, that this position at El Poso was "so far in rear that their fire was almost equally dangerous to friends and foes on account of the close proximity of the two firing lines," is simply childish and ridiculous, and shows only the inexperience, and lack of good judgment of its author, as has been seen, since the interior line of the Spanish trenches was nowhere closer than 800 yards from our most advanced line. With the well known excellent and certain quality of the fuzes of the light artillery projectiles it goes without saying that fire could have been maintained over our lines and up to or beyond the furthest Spanish line with absolute safety to our own line. The scream of the passing projectiles might not have been pleasant, and might have been trying to the *nerves* of those hearing it; but this shock would hardly have brought on any nervous prostration, and could and should have been borne without a flinch or a murmur, had our infantry and dismounted cavalry been a little more familiar with light artillery work. It is desired to make the protest now, and to make it emphatically against this unreasoning and unreasonable demand upon the part of the infantry and cavalry that the field artillery shall not, *shall never*, fire over them. If such a demand and proposition is to be allowed to stand unchallenged, and to become a part of the tactics of the battlefield, then a future disaster may result. The imperative demands of the battlefield are but poor respectors of "nerves," and exigencies and emergencies have arisen, and will constantly arise to make it imperative to use the field artillery in this manner. It might be well, therefore, looking forward to future events, for the infantry and cavalry to begin a few object lessons as to the possibilities of the field artillery. not only as to accuracy of its fire, but also as to the excellence and certainty of its projectiles, and their freedom from the defect of premature bursts.

But in the present campaign, however, it fortunately did not remain a necessity to remain at the El Poso hill as the only artillery position. San Juan hill had been taken, and could be held; all the lines in our possession could also be held, and it now became a problem of extension of lines, and the investment of the city.

General Lawton, who appears to have some appreciation of the necessity for artillery in his work, applies for and receives Capron's battery as a part of his forces of investment. On July 3rd Captain Capron reports: "Left for position on the right of the line. Went into camp near firing line, 6:30 p. m., at 11:30 p. m. left camp and camped back of protecting line with Fourth Infantry.

"July 5th. Left that camp at 9 a. m., arrived at position overlooking Santiago 10 a. m. Threw up intrenchments to include 9th instant. Range from 1,200 to 2,500 yards.

"July 10th. Began firing on enemy's lines and batteries in front of Santiago at 4:30 p. m., continuing until dark.

"July 11th. Opened fire on enemy's lines and batteries at about 6 a. m., continuing intermittantly until 1 p. m.

"The firing has been active, accurate and destructive. The men behaved well and did all that was expected of them."

(See page 413, Report of the Major-General Commanding the Army, 1898).

Lieutenant Ernest Hinds, 2nd Artillery, reports:

"On July 7th I was ordered to report to General Lawton, who assigned me a position at the extreme right of our line, to the left of the railway leading into Santiago. During the night of the 7th. and during the 8th and 9th, the battery was thoroughly intrenched in this position, which was a very commanding one, overlooking the Spanish trenches at about 1,200 yards, and their forts at slightly greater ranges. On the afternoon of Sunday, the 10th, at about 4:45 we opened fire at the "Three Palm Battery." For a short time the atmosphere was very quiet, and our smoke interfered greatly with aiming and observation of the effects of our fire; but after a short while the wind began to clear the smoke away, and after a few shots we silenced the battery (1 gun). We then fired at the infantry trenches in our front and afterwards at the blockhouses and artillery on our left front, extending our fire finally across to the blockhouses beyond Fort Canosa. Before dark all the enemy's artillery fire, and practically all his infantry fire had ceased. Our fire ceased at 7:15 p. m. under orders from the division commander.

"At sunrise Monday, the 11th, we opened fire, which was continued slowly until 1 p. m., when orders were received to stop firing. We did considerable damage, apparently, by bursting shell and shrapnel in the trenches and blockhouses. There was no reply to our fire on this day except that of a few sharpshooters.

"We had no casualties during the two days action."

* * * * *

(See page 414, Report of the Major-General Commanding the Army, 1898).

As to the effect of the fire of Capron's and Hinds' batteries something will be quoted later; any comment by the writer would appear not only to be unnecessary, but an actual impertinence.

Returning now to El Poso hill for a moment we find that on July 3rd Captain Best's battery took a new position; he reports:

"On July 3rd the battery took position on a crest about 1,200 yards east of Fort Canosa; opened fire at about 4:30 p. m., July 10th, ceased about 6 p. m., opened ffre again the next morning and continued till about 2 p. m. (a truce had been declared to commence at 1 p. m., but this was not known by me till 2 p. m.)"

* * * * *

(See page 414, Report of the Major-General Commanding the Army, 1898).

Captain Grimes also took a new position, he reports:

"The battery remained in position at El Poso until July 5th, when it was conducted to a commanding position on the left, overlooking the trenches occupied by General Bates' division. The position was prepared, and gun pits were dug, and the battery remained here with nothing of interest occurring until about 5 p. m., July 10th, when orders were given by Major Dillenback, commanding light artillery battalion, to look for and fire on any target of the enemy which might present itself. We fired about 60 rounds at field guns in three different points in our front, and which I believe our guns started into activity, as there had been no firing until Captain Best's and mine began to fire.

"The firing was kept up as long as we could see. No shots from the enemy's artillery reached the battery, though some shrapnel were seen to burst near our infantry trenches.

"Sergeant James C. Skidmore and Private Charles Richter, A, Second Artillery, were slightly wounded by small-arms fire in this affair.

"On July 11th orders were given to fire on any target presenting itself, by Major Dillenback. I fired about 20 rounds during the morning at a gun located in what appeared to be a cemetery. The range was about 3,700 yards. We could not observe the effect of our fire, but the gun stopped firing after a few shots, being seemingly overpowered by the fire from Captain Best's and my battery. All firing ceased about 12:30 p. m. on announcement of renewal of truce, which had been pending on and off since July 3rd."

(See page 410, Report of the Major-General Commanding the Army, 1898).

In the meantime what has become of the two batteries of heavy artillery that accompanied the expedition to Cuba?

But slight information is at hand. Yet it is known that these batteries were positively forbidden to take their guns on shore at Daiquiri. Two seige guns were landed at Siboney, but were not brought up to the front. During the first part of the campaign these batteries appear to have been utilized for provost duty. Later they were brought up to the front, and went into position on the right of the First Cavalry; by July 6th, eight field mortars, 3".6 caliber, were brought up in army wagons, and were put in position. The two batteries took part on July 10th, shelling trenches and blockhouses. Captain Ennis, in command of the battalion, makes the following report:

"On the termination of the truce between the two armies, July 10th, 1898, this battalion, consisting of batteries G and H 4th Artillery, was in action with the enemy before Santiago de Cuba. Fire was opened at 4 p. m. from four 3".6 mortars. Nineteen shrapnel were expended. There were no casualties in the battalion."

(See page 409, Report of the Major-General Commanding the Army, 1898).

Two additional field batteries arrived in Cuba, viz: Taylor's of the 4th Artillery, and Reilly's of the 5th Artillery.

In the absence of any reports but little information is to be had. What little is known is from an officer then serving with Taylor's battery. He says:

"Began landing Sunday, July 10th, at Daiquiri.

"Finished landing and left Daiquiri 12 m. on 13th, leaving behind five caissons, and battery wagon, with small detachment in charge.

"Bivouacked in road at Seville night of 13th.

"Arrived at Shafter's headquarters 8 a. m. of 14th.

"In position right of Capron's battery 9:45 a. m., 14th. Could have gone into action at once. Got orders not to dig that day. On 15th orders came to dig gun pits, and get ready in case of any hitch. Remained in position until 17th. Went into camp at Caney after this. Reilly's battery had practically the same experience; had position away on the right. Both of these batteries were full six-gun batteries."

We thus see that before June 17th, there were in all four four-gun batteries, two six-gun batteries, or twenty-eight 3.2-inch field guns, and eight 3.6-inch field mortars in position in front of and surrounding Santiago de Cuba. No siege guns nor siege howitzers or mortars had been brought up.

As an illustration of the utter unreliability of statements based upon "Camp rumor," no matter how honestly believed and narrated, we may be permitted to invite attention to the following extract from *Scribners Magazine*, May number, page 483, where we find the following:

"The American field artillery was now under the command of General Randolph, and he fought it effectively."

This refers to the re-opening of hostilities "shortly after mid-day" on the 10th of July; let us look at the *facts* a moment.

General Randolph, through no fault of his, did not land until Sunday, July 10th, he not having arrived at Daiquiri until July 9th, and did not proceed to the front until somewhere in the *afternoon* of that day; hence the resumption of hostilities on July 10th, on or about "mid-day" (the firing by the artillery did not begin until after 4 p. m., however) found the original four light batteries of the Fifth Corps already posted and entrenched; as General Randolph could not possibly have arrived at the front until long after this resumption of hostilities, he could not possibly have made any redisposition, or have taken charge and have given any orders. He may have, and probably did give orders as to the placing of Taylor's and Reilly's batteries, *which did not arrive at the front until after July 11th, the last day of the firing*, and hence did not fire a shot. We see therefore that the statement quoted above is absolutely without foundation in fact, and can be dismissed from further consideration.

Turning now to Spanish authority, presuming first of all that Lieutenant Tejeiro's account is necessarily inaccurate, and hence must be taken with many reservations, let us see what he says, or reports others as saying as to the effect of our artillery fire:

Page 91, XXXII. "July 10th General Shafter gave notice that hostilities had again broken out since 4 in the afternoon. * *

"On the 10th the enemy, already in the trenches, and being in possession of all the adjoining heights where he has installed numerous modern guns, opened a lively musket and gun fire, at 5 p. m. upon a great extent of our line. The artillery answered firmly, but there was hardly any musket fire, because orders had been given and complied with to economize ammunition at any cost.

"Two hours previonsly, our advance forces had withdrawn to the city, abandoning the foremost position at Dos Caminos del Cobre, first setting it on fire."

* * * "The battle was limited to firing from the trenches. Nevertheless, as the enemy was very numerous and his lines only a few meters from ours, we had 7 dead and 47 wounded. During the engagement the Americans abandoned two trenches which they could not hold because they were flanked by ours. * * *

"In the meantime (the 11th) the enemy continued to antagonize our lines in order to compel the soldiers to consume the scant ammunition that remained, but orders had been given not to answer the fire, and so there was hardly any musket fire. Gun fire only answered very slowly, as is necessary with antiquated guns. The enemy, on the other hand, was constantly receiving modern guns and setting them up rapidly." * * *

Page 92. "For a better inside understanding of the events and engagements of the 10th and 11th of July, I will copy below the official report * * * of Lieutenant of Artillery Moreno to General Escario, as also a statement of the shots which our guns fired during these days. One need only to glance at the statement referred to to see at once that on the first day 167 shots could be fired, and the next day, being the 11th, only 35, because the enemy had dismounted and disabled some of our guns. A simple calculation is sufficient to understand that the following day not a single shot could probably have been fired. Before such proofs, comments are unnecessary.

* * * * *

"Copy of the report made by the first lieutenant in charge of the artillery of the sector:

"ARTILLERY, CITY OF SANTIAGO DE CUBA,
SECTOR FROM THE PORTILLO DEL CANEY TO SAN ANTONIO.

"HONORED SIR: Fire was opened by the enemy yesterday at 4.45 p. m., and the batteries of this sector made it their business to silence it, or at least diminish it as much as possible, given the limited effectiveness of the guns which formed them—most of them muzzle-loading—and the reduced caliber of the only four which are of modern types, and can therefore keep up an accurate and rapid fire. The enemy's batteries, as has been observed on previous days by means of glasses, and as we have experienced practically to-day, are quite numerous, very well installed without leaving any space uncovered, and occupy positions overlooking ours, and are for that latter reason well adapted to train successfully, and to be of great moral effect on our troops, who are harassed almost vertically by the grapeshot (shrapnel?) inside the trenches. The guns of these batteries are of small and medium caliber, as may be seen from the size of their projectiles, and the shape of the latter shows that they are breech-loading guns, and for that reason alone, of the greatest advantage over ours. A few fire dynamite projectiles, but it was noticed that they are of little accuracy, although very effective when they explode. At the same moment when the musket and machine-gun fire was opened, which was hardly answered from the city, gun fire also commenced, and as the effect of the shells began to be felt at the first shots, it became necessary for us to do what we could to decrease the cannonade. Firing was commenced on the whole sector at the same time and with such rapidity as each gun permitted, except the Plasencia guns, for if we had continued to fire them with the same rapidity as the gunners, anxious to injure the enemy, had commenced, we would have consumed the whole of the ammunition in two hours. All the shots were made under the action of a constant musket and machine-gun fire, aimed particularly at the batteries, for the apparent purpose of not allowing us to come out of the trenches to load and train our guns. In view of the sustained artillery fire from the city the enemy moderated his somewhat, especially in the sector between Nispero and San Antonio, and by 6 p. m. the only guns that were doing any firing worthy of mention were those installed opposite the Portillo del Caney. This circumstance was very favorable for us. The ostentatious artillery fire which we did during the first moments checked the enemy's rapid fire along the greater part of the line, and if this had not been the case we should have been compelled to keep silent before his batteries, for of the 12 guns of different calibers of the batteries of Nispero, Sueño, Santo Inès, and San Antonio, we had left at the hour mentioned only three 8-cm. guns; the others had been put out of action, the carriages of most of them having been disabled. The batteries of Portillo del Caney continued to answer the fire, which was aimed at them particularly without a moment's cessation, and in one of them I was an eye witness of an incident worthy of mention. A training gunner of one of the 8-cm. Plasencia guns, whose captain had been previously wounded, was shot through one arm, and he continued to train, for fear that there would be no one to relieve him, until, a relief having been effected, he was obliged to go to the nearest hospital. At the same moment an artillerist came out with a mule and ran in the direction of the headquarters at Concha, passing through the musket and machine-gun fire, shouting, 'Long live Spain!' through the streets. He was on his way to get another supply of common shells for the gun, its supply having been consumed during the first shots. These incidents, and similar ones which no doubt occurred all along the line and in the trenches, show, honored General, that while the enemy had succeeded, owing to the superior position of his batteries, in acquiring greater accuracy of fire, he had not been able to quell the courage of our soldiers, always cool-headed before the greatest danger, even to the very last moment.

"At 7 p. m. the firing ceased, leaving us in bad condition for to-day, because, as I have already stated, only two 16-cm. and three 8 cm. guns, and two 8-cm. Plasencia, and two rapid-fire Krupp guns, are all that are available for the defense, and the majority of the mounts for the old ones are somewhat defective.

* * * * * * * *

"At 5.30 a. m. to-day fire was opened by a few musket shots, and a few minutes after the artillery battle commenced. The batteries with which the enemy fired yesterday are not the only ones he has; he also has large caliber guns, or perhaps howitzers, which, being installed at a considerable distance from the city and covered by the hills, keep up a constant fire upon us, which we are not able to answer. Yesterday we could distinguish the flashing from the batteries erected between the Portillo del Caney and San Antonio, and to-day we can see only three opposite the said Portillo; the others were firing completely under cover, and we were not even able to disturb the composure with which they were trained. It is known that we did them some damage yesterday, and that is perhaps the reason why they have taken this position to-day. Only two shots were fired in the morning at Santa Inès and two more at San Antonio. And the rest of the day we have been able to fire only from the 8-cm. Plasencia battery and the 7.5 rapid-fire Krupp battery, erected at the Portillo del Caney and Palomar, respectively, which had opposite them three 9-cm. batteries of the enemy at a distance of 1,100 meters from the former and 1,600 meters from the latter. From the first moment it could be seen that the enemy's objective was to bombard the city, and his fire was aimed entirely at the target. Yesterday they took the exact distance from their batteries to the principal points of the city, and to-day making use of yesterday's notes, they put the shells just where they wanted, and the trajectories of those from the same battery were almost identical. I repeat that there were only three in sight, and upon these three we opened fire at 6 a. m. with the rapid-fire guns. When the first shot was discharged the enemy partly changed his objective, and soon the battery mentioned and one of the hidden ones, aimed their fire at Palomar, but were not able to hit the rapid-fire guns until 10 a. m., because these guns, being of reduced dimensions, in sunken battery, and with hardly any smoke from the discharge, were hardly visible to the enemy. For four hours we fired without knowing where we were, but very slowly, because the number of ordinary shells and grapeshot for the guns referred to is already very small. After these first four hours were over the enemy answered each shot with 8 or 10 of his, which, with almost mathematical precision, were aimed at the battery. About the same thing, but on a greater scale owing to the proximinity of the opposing batteries and the good target formed by the smoke which developed at each shot, happened at the Plasencia guns. Since 8 o'clock in the morning, when the fire was opened, until 3 in the afternoon, the places where the guns were erected were veritable centers of impact, since we had only two batteries and the enemy a great many. And when a shot was fired, all concentrated their fire on the one that had discharged. In order to fire at all, it was necessary to make the enemy believe, by using artificial means, that the gun had been put out of action. When this did not succeed, the gun fire aimed at the battery was incessant, and made it impossible for us to load and train. As I have stated, at 3 p. m. the firing ceased, and yesterday as well as to-day I noticed the greatest order among the officers and men in charge of the different batteries. At the Plasencia guns, the second gunner, Antonio Escriba Escriba, belonging to the 2d section of the 1st battery of the 5th Mountain Regiment, was wounded. The total number of shots fired yesterday and to-day is as follows: 16, with the rapid-fire guns; 33, with the 8 cm. Plasencia guns; 29, with the 8 cm. guns; 63, with the 8-cm. short breech-loaders; 10, with the 16-cm. and 10 with the 12-cm. bronze guns.

"May God guard your excellency for many years.

"JUAN MORENO,
"*First Lieutenant,*
Commanding artillery of the sector.

"SANTIAGO DE CUBA, July 11, 1898."

"The guns which the Americans had in the batteries of the circle were all of modern type, with calibers of 8, 9, 7. and 7.5 cm. They fired mostly grapeshot (shrapnel?) with 10 per cent. ordinary shells. They also made use of dynamite shells, but the number of these projectiles did not exceed 5 per cent. of the total number thrown upon the city.

"The batteries that were most persistent in firing on the 10th were those erected in the vicinity of the Caney road, and they fired only about 150 shots, with an average rapidity of 14 or 16 shots per hour and battery. The others, which ceased firing an hour earlier, discharged about 100 shots.

"On the 11th the gun fire was more sustained, but slower. All the batteries fired about alike and discharged in all about 700 shots."

BATTERIES OF THE PRECINCT OF THE CITY OF SANTIAGO DE CUBA.

BATTERIES AND GUNS.	No. of shots	
	10th	11th
Fuerto Nuevo:		
One 12-cm. muzzle-loading bronze gun	1	....
Cañadas:		
One 16-cm. muzzle-loading bronze gun	2	....
Santa Ursula:		
Battery No. 1: Two 8-cm. muzzle-loading bronze guns	10	....
Battery No. 2: Two 8-cm. long muzzle-loading bronze guns	8	....
Battery No. 3: Two 9-cm. long muzzle-loading bronze guns	16	6
Portillo Caney:		
Battery No. 1: Two 8-cm. short breech-loading bronze guns (Plasencia system)	25	10
Battery No. 2: Two 8-cm. long muzzle-loading bronze guns	24	....
Nisero:		
Battery No. 1: One 16-cm. muzzle-loading bronze gun	1	....
Battery No. 2: One 12-cm. muzzle-loading bronze gun	2	....
Battery No. 3: Two 8-cm. short breech-loading bronze guns	30	....
Sueño:		
Battery No. 1: One 16-cm. muzzle-loading bronze gun	3	....
Battery No. 2: One 12-cm. muzzle-loading bronze gun	2	....
Battery No. 3: Two 8-cm. short breech-loaders	25	....
Santa Inés:		
Battery No. 1: One 16-cm. muzzle-loading bronze gun	2	2
Battery No. 2: One 12-cm. muzzle-loading bronze gun	4	....
Battery No. 3: Two 8-cm. short breech-loading guns	10	....
San Antonio:		
One 16-cm. muzzle-loading bronze gun	2	1
Palomar:		
Two 7.5-cm. short breech-loading rapid-fire Krupp guns	....	16

During the firing on the 10th, the following guns were put out of action: The gun of the battery of Fuerte Nuevo; one of each of the Santa Ursula batteries; the two of battery No. 2 of the Portillo del Caney; those of the Nisero batteries Nos. 2 and 3; those of batteries Nos. 1 and 2 and one of battery No. 3 of Sueño; and that of Battery No. 2 and one of Battery No. 3 of Santa Inés.

To sum up, there were disabled: four 12-cm., one 16-cm., eight 8-cm. guns, old systems, and one 9-cm. breechloader.

The 9-cm. gun was disabled by the enemy, as also one of the 12-cm. guns of Sueño, the cause being that the 12-guns were mounted on "skeleton" carriages that did not belong to them, and broke at the first or second shot, and that the 8-cm. old guns, although mounted in their own carriages, these being of wood and in bad repair, they had the same fate as soon as a few shots were fired. The 16-cm. gun was disabled by the cartridge sticking in the chamber.

To the above, and particularly to the report of Lieutenant Moreno, it would appear unnecessary to add any comments; suffice it to invite attention to the "almost mathematical precision" with which our guns were aimed, enabling our artillery to "put the shells just where they wanted," and making "the trajectories of those from the same battery * * * almost identical;" no wonder "the places where the guns were erected were veritable centers of impact," and that our fire overwhelmed that of the enemy.

In conclusion it must be confessed that the temptation is strong to animadvert upon the spirit as well as the fact of the unwarranted and unjust, not to say absolutely false criticism and statements that have appeared concerning the light artillery at Santiago, upon which statements the extracts forming the text of this article are evidently based. But such animadversion could not be otherwise than personal, and would not lend any dignity to the conclusion drawn, or attempted to be drawn, from the above narrative based upon observation and official reports. These official reports now first appear before the public; none of them were "rushed into print" to appear before the public even before they reached the office of the Adjutant-General, and hence now for the first time the artillery at Santiago appears before the public from an artillery standpoint.

The artillery are no "heroes"!!!, but simply "plain regulars," to whom "playing to the galleries" is beneath contempt. It is but simple justice that is asked, firmly believing the justice of its cause and its vindication; it is to assist such investigation that this article, and the papers here appended, are respectfully submitted.

Appendix.

In the Field, Before Santiago de Cuba,
July 17, 1898.

Adjutant Light Artillery Battalion.

Sir: In compliance with the instructions from the commanding officer Light Artillery Battalion, of the 15th instant, to submit report of the operations of my battery, commencing with Tampa and ending with the fall of Santiago de Cuba, I have the honor to submit the following:

The battery arrived at Port Tampa, Fla., May 1, 1898, and went into camp near the beach. The equipment, consisting of 4 guns, 4 caissons, and battery wagon and about 1,200 rounds of shell and shrapnel, were June 2 and 3 loaded on the transport *Iroquois*. On June 6 the personnel, consisting of 3 officers, 80 men, 75 horses, baggage and camp equipage, were loaded on the transport *Berkshire*.

On June 9 the horses were put ashore and again put on board June 13, on which date the "army of invasion" sailed for Cuba. Two horses died at sea.

The expedition arrived off Santiago June 20. The horses were disembarked June 23 at Daiquiri, the guns on the 25th, and the men and ammunition on the 26th. Six hundred and seventy-two rounds were put in the chests in the proportion of one common shell to three shrapnel, and thirty-two canister were carried in boxes. Orders to proceed toward Santiago were given and the battery marched out of Daiquiri about 4 p. m. and camped near Siboney about 7 p. m.

The march was resumed the following morning at 6 a. m. and continued to a point near corps headquarters (Sevilla), making camp about 3 p. m. on the 27th. The march from Daiquiri to this latter point was conducted by Lieutenant Conklin, I being overcome by the heat and exhaustion at Daiquiri and unable to travel. I rejoined the battery on the 28th.

On the 30th I was ordered to report to General Shafter at 7 a. m., and a little later I accompanied him to El Poso, where, on a ridge near by, I was directed to prepare and occupy with my battery on the following day. The battery was brought to El Poso on the afternoon of the 30th, arriving about 4 p. m.

At dawn July 1 gun pits were dug on the crest of the ridge, fronting a blockhouse on San Juan Hill. The guns were in position about 7 a. m. About 8 a. m. I received orders from Colonel McClernand, adjutant-general Fifth Army Corps, to open fire on the blockhouse. The range, about 2,600 yards, was quickly found, and very soon a Spanish field battery returned our fire. They promptly got our range and then shrapnel was soon bursting near the battery. The duel continued, with brief pauses, until about 2 p. m., when our troops were seen ascending the San Juan Hill near the blockhouse. The Spanish battery was apparently silenced quite early in the engagement. The balloon, which ascended between the lines and close to our line of fire on the blockhouse, attracted the fire of the Spanish guns and prevented me from returning it until the balloon descended.

The action of the battery throughout the engagement was directed against the enemy's guns near the blockhouse. Later in the engagement the enemy's artillery opened on our troops from a position on the ridge on our right of San Juan blockhouse, and my fire was directed on these guns and on the trenches along and in front of this ridge until firing ceased, about 2 p. m. The battery was at no time under small-arm fire. The casualties in the battery for the day were:

Killed.—Artificer Victor Helm, Private Asa B. Underwood.

Wounded.—First Sergt. George C. Kenry, Sergt. Charles E. Veite, Sergt. William E. Cornford, Corpl. Herbert D. Keene, Private Samuel Barr.

Three horses were also wounded. About 160 projectiles were fired during the fight.

About 7 p. m. July 1 orders were received from Colonel McClernand to move from El Poso to the front and report to Major Dillenback, commanding the Artillery Battalion. I reported to him about 10 p. m. near General Wheeler's headquarters (near San Juan Hill), and was ordered to bivouac.

About 1.30 a. m. July 2 I was called to accompany Major Dillenback, Captain Best, First Artillery, and Captain Parkhurst, Second Artillery, to find positions for batteries K, First Artillery, and A and F, Second Artillery. The batteries were put in position before daylight on the ridge near (to the right of) the San Juan blockhouse. I put my guns in the trenches dug by the infantry the day before. About dawn bullets began to fly about the battery and orders were given for the batteries to open fire. Nothing whatever could be seen through the darkness, mist and smoke, but in accordance with orders I directed my fire on the town. After firing about 30 rounds orders were given to withdraw, which was done with difficulty under heavy small-arms fire and some shots from field guns. Private Jesse F. Gates, A, Second Artillery, was severely wounded in this affair.

The batteries returned to El Poso and, all four of the batteries of the battalion being now together again, were intrenched along the ridge occupied by my battery in the action of July 1. On the road to El Poso from the second position on San Juan Hill we were subject to guerilla fire from trees along the road. Lieutenant Conklin narrowly escaped receiving a severe wound, a shot passing close to his knee and through his saddlebag and wounding his horse in the side.

The battery remained in position at El Poso until July 5, when it was conducted to a commanding position on the left overlooking the trenches occupied by General Bates's division. The position was prepared and gun pits were dug and the battery remained here with nothing of interest occurring until about 5 p. m. July 10, when orders were given by Major Dillenback, commanding light artillery battalion, to look for and fire on any target of the enemy which might present itself. We fired about 60 rounds at field guns in three different points in our front and which, I believe, our own guns started into activity, as there was no firing until Captain Best's and mine began to fire. The firing was kept up as long as we could see. No shots from the enemy's artillery reached the battery, though some shrapnel were seen to burt near our infantry trenches.

Sergt. James C. Skidmore and Private Charles Richter, A, Second Artillery, were slightly wounded by small-arms fire in this affair.

On July 11 orders were given to fire on any target presenting itself by Major Dillenback. I fired about 20 rounds during the morning at a gun located in what appeared to be a cemetery. The range was about 3,700 yards. We could not observe the effect of our fire, but the gun stopped firing after a few shots, being seemingly overpowered by the fire from Captain Best's and my battery. All firing ceased about 12.30 p. m. on announcement of renewal of truce, which had been pending on and off since July 3.

In all the operations of the campaign now terminated our artillery, while apparently always superior to the enemy's in point of number of guns, has been at a great disadvantage in the matter of powder. The enemy's artillery used for the most part smokeless powder. We still cling to black powder. We should be supplied with smokeless powder with the least possible delay.

I desire to state that the conduct of the battery throughout the campaign has been excellent, every man responding with promptness and zeal to the demands made upon him and enduring exposure and privation without a murmur of discontent or complaint.

I desire especially to commend the conduct of Corpl. Herbert D. Keene, who, although wounded in two places in the action of July 1, returned to the battery after his wounds were dressed and continued serving his gun throughout the day.

I desire also to record my appreciation of the zeal and good conduct exhibited by First Lieut. John Conklin, jr., and Second Lieut. Otho W. B. Farr, Second Artillery, throughout the campaign, and to commend especially the skillful and efficient manner in which they directed the fire of their platoons in the action of July 1.

First Lieut. W. W. Quinton, assistant surgeon, U. S. Army, and Private Michael J. Gresham, Hospital Corps, have been on duty with the battery throughout the campaign, and have discharged their duties in an efficient and satisfactory manner.

Very respectfully,

G. S. Grimes,
Captain, Second Artillery, Commanding Light Battery A.

Camp Light Artillery Battalion,
Near Santiago, July 15, 1898.

Adjutant-General Fifth Army Corps.
(Through commanding officer Artillery Brigade.)

Sir: I have the honor to submit a report of the operations of the light artillery battalion, consisting of batteries E and K, First Artillery, and A and F, Second Artillery, under my command, from its departure from Tampa, Fla., the afternoon of June 13, 1898, to the 14th of July, 1898, the end of the campaign, which resulted in the surrender of the Spanish forces at Santiago, Cuba.

The battalion arrived off the town of Daiquiri, Cuba, June 23, and the horses were unloaded from the ships by swimming them ashore, and the guns, ammunition and material by means of lighters—a tedious and delicate means of disembarking, requiring the greatest care and attention, but which was successfully accomplished without accident.

Under orders of the commanding general, Light Battery K, First Artillery, was disembarked on the night of June 24, and proceeded the next morning, as soon as rations and forage could be drawn and ammunition packed in chests, toward the front. The guns of Light Batteries A and F, Second Artillery, were disembarked the following day, and on the 26th, as soon as supplied as above, and orders received, the batteries moved to the front and reported to General Wheeler for instructions.

On June 28 Light Battery E, First Artillery, came up, and the battalion of four batteries was complete.

Early in the afternoon of June 30 Capron's battery (E, First Artillery) and Grimes's battery (A, Second Artillery) were, by the commanding general, detached, the former to report to General Lawton, on the right of our line, and the latter to General Wheeler, on the left.

On the morning of July 1 I was ordered to take the two remaining batteries to the front and assist Grimes's battery that was engaged at El Poso in shelling the enemy's works, and was under a hot fire from the enemy's guns. The enemy used smokeless powder and the position of the guns was hard to locate. I placed Best's and Parkhurst's batteries on Grimes's left, and after a vigorous shelling of the enemy's works on the ridge by all three batteries, the position was occupied by our infantry.

Early in the afternoon of July 1 Best's battery was ordered to the extreme front and placed on the firing line, but the fire of the enemy's artillery, which could not be located, and a very severe fire from intrenched infantry, caused it to withdraw to a hill a few hundred yards in rear, where I joined it with Parkhurst's battery at about 4 o'clock. About 6 o'clock I received information that Grimes's and Capron's batteries had been ordered up, and I was ordered by the commanding general to shell the city of Santiago with the four batteries at daybreak.

During the night, in company with the three battery commanders (Captain Capron did not report from the right until the next day), I thoroughly examined the ground for a suitable position for carrying out the orders of the general commanding, and the only place possible at our extreme front was the position occupied by Best's battery in the afternoon. The rest of the time before dawn was occupied in getting into position and erecting hasty cover for our men and guns, which was far from complete and did not afford a suitable position.

When the batteries commenced the enemy opened upon us with artillery and infantry from intrenched lines and sharpshooters but a few hundred yards away, and the men were unable, owing to the severe fire, to properly serve the guns. The enemy were so near at one time that canister was used upon them. That there were not more casualties was due to a steep slope from the ridge which afforded protection to the drivers and also to the cannoneers when not serving the guns. Ammunition was obtained by the men crawling to the limbers on their hands, knees and bellies, and returning to the guns in the same way. Our guns were on our extreme front, and in some cases in front of our intrenched infantry line. After remaining in that position about an hour, firing when possible, the situation as stated above having been communicated to General Wheeler's aid, General Wheeler authorized me to withdraw the batteries to El Poso, where Capron's battery reported to me at 8.30 a. m. and was placed on the line with the other batteries.

On the 3d of July Capron's battery was ordered to report to General Lawton, on the right of the line, and on the 7th Parkhurst's battery, now commanded by Lieutenant Hinds (Captain Parkhurst having been wounded on the morning of the 2d instant), was also directed to report to General Lawton. Both batteries since that time have been on that line, and not under my immediate personal supervision, as I remained on the left with the other two batteries.

On July 3 and 4 the remaining batteries were withdrawn from El Poso and placed on prominent ridges on the left nearer the city, overlooking the enemy's position, and within easy range of the same.

The four batteries of the battalion shelled the intrenchments and guns of the enemy on the 10th and 11th of July, and, it is believed by those engaged, very successfully.

Ordere were received the evening of the 13th to move Grimes's and Best's batteries to the extreme front on our left and intrench them there. Intrenchments were prepared for one battery early on the afternoon of the 14th, and Best's battery was on the march to occupy them when orders met us directing us to go into camp elsewhere.

During the campaign just ended the artillery suffered the disadvantage of having a large extent of territory to cover with a totally inadequate number of guns, there being only about one to every thousand men, whereas our drill regulations and the best military writers recommend at least three or four for that number ef men, wherever the terrain will permit of their use. The close country through which the troops have advanced, and bad roads, and the weakened condition of the horses, due to a long sea voyage, and the limited number of guns (16), and scarcity of positions obtainable, and the inability, for the above reasons, to maneuver rapidly on the scene of operations, rendered it impossible to give support to the other arms at all parts of the extended line that encircled Santiago. Wherever a position bearing on the enemy where artillery could be maintained was found, it performed excellent work, and is believed to have inflicted serious injury upon the enemy. Single batteries from time to time have been detached, and their work while so detached has not come under my personal observation, but on all occasions where I have been present the officers and men under my command, under fire and on all other occasions, have performed their whole duty bravely, cheerfully and well. Had positions been obtainable and the country been of such a nature that the battalion could maneuver rapidly, the guns would have been more frequently heard and support would have been given to different parts of the line not attainable during the recent engagements. During a state of siege, which did not exist on July 1 and 2, time permits the intrenchment of batteries, and positions can be held when so intrenched at the extreme front, even on the firing line, but time and much labor are necessary to make this possible.

During the campaign just ended the casualties in the battalion I commanded were as follows: Killed—1 sergeant, 1 artificer, and 1 private; wounded—1 officer, 5 non-commissioned officers, and 5 privates.

I would respectfully invite attention to reports of battery commanders.

Very respectfully, your obedient servant,

John W. Dillenback,

Major, Second Artillery, Commanding Light Artillery Battalion.

Light Battery E, First Artillery,
Near Santiago de Cuba, July 7, 1898.

Adjutant-General Division, Fifth Army Corps.

Sir: I have the honor to make the following report in pursuance to instructions:

The battery left camp near Sevilla about 2 p. m. June 30, and went into camp about 8 p. m., about 2,500 yards from Caney. The battery formed for action at daybreak July 1, and opened fire under personal orders of the major-general in command about 6.15 o'clock a. m., and continued its fire against specified objectives intermittently throughout the day under the personal direction of the division commander. The results against visible targets and the action of the projectiles appeared uniform and effective. The projecting charges varied somewhat, as is usual, but not enough to seriously affect the ballistic results.

Very respectfully, your obedient servant,

Allyn Capron,

Captain, First Artillery, Commanding Light Battery E.

In Camp, Santiago, Cuba, July 15, 1898.

Respectfully submit the following:

June 13.—Left slip at Port Tampa on board steamer *Comal.*

June 20.—Arrived off Santiago de Cuba about 11.20 a. m.

June 22.—Anchored off Daiquiri.

June 23.—Began unloading horses.

June 24.—Finished unloading horses.

June 25.—Men of battery came ashore at Daiquiri.

June 26.—Material of battery unloaded.

June 27.—Left Daiquiri 9.30 a. m.; arrived at Siboney 2 p. m.

June 28.—Left Siboney 6 a. m.; arrived at camp near Sevilla 10 a. m.

June 30.—Left camp near Sevilla 3.30 p. m. and took position near El Caney 8.30 p. m. to fire on El Caney the following day.

July 1.—Fired shell and shrapnel into El Caney (range 2,400 yards) 6.15 a. m. to 11.30 a. m. Recommenced 12.30 a. m., continuing until 2.10 p. m. Changed position for one 1,000 yards from El Caney and fired into two blockhouses. Battery marched toward Santiago and about dark halted on road and bivouacked for the night about 1 mile from Santiago.

July 2.—Orders received to move about 2 a. m July 2. Reached a position on left of line 8.30 a. m. with the other three batteries. Gun pits dug there (El Poso).

July 3.—Left for position on right of the line. Went into camp near firing line 6.30 p. m. At 11.30 p. m. left camp and camped back of protecting hill with Fourth Infantry.

July 5.—Left that camp at 9 a. m. Arrived at position overlooking Santiago 10 a. m. Threw up intrenchments to include 9th instant. Range from 1,200 to 2,500 yards.

July 10.—Began firing on enemy's lines and batteries in front of Santiago at 4.30 p. m., continuing until dark.

July 11.—Opened fire on enemy's lines and batteries at about 6 a. m., continuing intermittently until 1 p. m.

The firing has been active, accurate, and destructive. The men behaved well and did all that was expected of them.

Respectfully submitted,

ALLYN CAPRON.
Captain, First Artillery, Commanding Light Battery E.

CAMP LIGHT BATTERY K, FIRST ARTILLERY,
One and one-half miles east of Santiago, Cuba, July 15, 1898.

Maj. JOHN W. DILLENBACK,
Second Artillery, Commanding Light Artillery Battalion.

MAJOR: In compliance with instructions of this date, I respectfully report as follows regarding the movements of this battery:

The battery embarked from Port Tampa, Fla., on the transport *Comal* June 6; debarked the horses the 8th of June, reloading them on the 13th. The *Comal* reached Daiquiri, Cuba, June 23. The horses were swam ashore on the 24th and 25th. Orders were received late on the afternoon of the 25th to debark the men and carriages and proceed to the front, pushing at least one platoon on as soon as possible. By about 8 a. m. of the 26th the right platoon was started, the rest of the battery following about 10 a. m. The entire battery encamped at Siboney during the night of June 26. No forage was procurable at Siboney during the forenoon of the 27th and it was understood that none had gone to the front. Lieutenant Lassiter rode forward to General

Wheeler's headquarters (about 6 miles beyond Siboney) and explained the forage condition. General Wheeler sent word by Mr. Lassiter that the battery might come up by easy stages. No forage having reached shore by 3.30 p. m. (I had a party on ship since about 9 a. m. endeavoring to procure it) I marched back about a mile and encamped in a cocoanut grove as the camp ground at Siboney I considered to be unhealthy.

March was resumed the next day, the battery reaching Sevilla (about 6 miles north of Siboney) and camping there till July 1.

On July 1 about 2 p. m. the battery took station on a ridge just to the left of Light Battery A, Second Artillery, and opened fire on Fort Canosa and trench in front. In a few moments our troops were in possession of those points and firing by the battery ceased. In a short time the battery was ordered forward and took station on the crest of the ridge about 200 yards to the northward of Fort Canosa, and while there was in the front line of the battle, our infantry that lay a few yards behind the crest before the battery reached there, retiring about 50 yards as soon as the guns were in firing position. A rifle gun (about 5-inch caliber) concealed in trees just in front of the large building at the north end of Santiago (a building showing a number of Red Cross flags) opened on the battery, and the small-arms fire of the enemy became exceedingly vigorous from a stretch of rifle pits about 800 yards from our crest. Because of intervening trees only a stretch of about 30 or 40 yards of these trenches could be seen. Several ranging shots were fired at the puffs of smoke given off by the enemy's guns mentioned, but because of trees lying between it and us we could not get the range, as the bursts of our ranging shells could not be seen. Because of the intensity of the enemy's musketry fire, to work guns where ours were was not deemed practicable, and I ordered them withdrawn, Sergeant McCarthy being killed near the right flank just before the order to retire was given. The battery was in action ten or fifteen minutes.

The battery retired to a crest about 500 yards in rear of Fort Canosa hill. About 2 a. m. July 2 the battery again took station on the crest to the north of Fort Canosa, Light Battery F, Second Artillery, being on its right flank, Light Battery A, Second Artillery, being on the right of F. The battery intrenched somewhat. Our infantry was in trenches about 25 yards in front of the battery. The enemy opened on us about daylight with artillery and infantry. After being in action for half an hour or less the batteries were ordered to retire and took post at about the first position of July 1 and intrenched.

On July 3 the battery took position on a crest about 1,200 yards east of Fort Canosa; opened fire at about 4.30 p. m. July 10, ceasing about 6 p. m. Opened fire again the next morning and continued till 2 p. m. (a truce had been declared to commence at 1 p. m., but this was not known by me till 2 p. m.).

On the 14th the battery broke camp to take position south of the city on the crest occupied by General Bates's command. While en route to that point the surrender of the Spanish forces was announced and the battery returned to the camp it had just left.

Total number of rounds fired from July 1 to July 15, about 130.

Very respectfully,

CLERMONT L. BEST,
Captain, First Artillery, Commanding Light Battery K.

I would add that since landing the battery has been without wheeled or pack transportation of any sort, using its horses for getting both rations and forage. About 500 pounds of hay have been drawn, and on an average about half ration of grain.

CLERMONT L. BEST,
Captain, First Artillery.

IN CAMP NEAR SANTIAGO, CUBA, July 16, 1898.

ASSISTANT ADJUTANT-GENERAL,
Light Artillery Brigade.

(Through Maj. J. W. Dillenback, Second Artillery, commanding battalion.)

SIR: In compliance with verbal instructions given me by the commanding general Light Artillery Brigade, I have the honor to submit the following report:

I left Tampa, Fla., on the steamer *Louisiana*, June 27, 1898, under orders to join Light Battery F, Second Artillery; landed at Daiquiri at about 4.30 p. m. July 1. Left there at about 5.30 p. m. with Assistant Surgeon Kennedy, Medical Department, U. S. Army, who furnished me transportation to Siboney. Arrived at that place at about 7.30 p. m. Tried to procure transportation to the front, and not being able to do so I started, at 10.40 p. m., with the Thirty-fourth Michigan, to march to the front. Reached General Shafter's headquarters at daylight July 2, just before firing began at the front.

About one-half mile after passing El Poso I met Lieutenant Aultman, Second Artillery, who reported to me that Captain Parkhurst had just been wounded, and that he had been directed by Major Dillenback to take an order to Captain Capron not to bring his battery up on the line; and also that the three batteries on the line were ordered withdrawn. A few minutes later I met Major Dillenback and reported to him as being in command of Battery F, Second Artillery. He informed me that the battery which was at the head of the column was stalled in the San Juan River, and directed me to get it out and bring it back to El Poso, which was done. The battery was under the fire of sharpshooters for about half of the distance to El Poso. I took command of the battery at about 8 o'clock a m. July 2. On reaching El Poso I was ordered to go into position on the hill at that place where we remained until July 7. Captain Parkhurst and Privates Wass and McCay were wounded in the action on the morning of July 2.

On July 7 I was ordered to report to General Lawton, who assigned me a position at the extreme right of our own line, to the left of the railway leading into Santiago. During the night of the 7th, and during the 8th and 9th, the battery was thoroughly intrenched in this position, which was a very commanding one, overlooking the Spanish trenches at about 1,200 yards and their forts at slightly greater ranges. On the afternoon of Sunday, the 10th, at about 4 45, we opened fire at the "Three Palm Battery." For a short while the atmosphere was very quiet, and our smoke interfered greatly with aiming and observation of the effects of our fire; but after a short while the wind began to clear the smoke away, and after a few shots we silenced this battery (1 gun). We then fired at the infantry trenches in our front, and afterwards at the blockhouses and artillery on our left front, extending our fire finally across to the blockhouses beyond Fort Canosa. Before dark all the enemy's artillery fire and practically all his infantry fire had ceased. Our fire ceased at 7.15 p. m upon orders from the division commander.

At sunrise Monday, the 11th, we opened fire, which was continued slowly until 1 p. m., when orders were received to stop firing. We did considerable damage, apparently, by bursting shell and shrapnel in the trenches and blockhouses. There was no reply to our fire on this day except that of a few sharpshooters. We had no casualties during the two days' action.

I desire to call especial attention to the skill and coolness with which Lieut. D. E. Aultman directed the fire of his platoon on the afternoon of the 10th while under the fire of the enemy's artillery and infantry. I wish also to commend First Sergeant Hidlund, who was in charge of the left platoon, and whose services were most satisfactory indeed.

Very respectfully, your obedient servant,

ERNEST HINDS,

First Lieutenant, Second Artillery, Commanding Light Battery F, Second Artillery.

IN CAMP NEAR SANTIAGO, CUBA, July 16, 1898.

ASSISTANT ADJUTANT-GENERAL, *Light Artillery Brigade.*

(Through commanding officer, Light Artillery Battalion, Fifth Corps.)

SIR : I have the honor to make the following report of the movements and engagements of Light Battery F, Second Artillery, from its departure from Port Tampa, Fla., until I turned over the command to First Lieut. Ernest Hinds, Second Artillery, on the morning of July 2, 1898.

We left Port Tampa, Fla., on the transport *Berkshire* at 3 p. m., June 13, 1898, under command of Capt. C. D. Parkhurst, Second Artillery ; lay at Egmont Key till 4 p. m. the following day, when we proceeded on the voyage. We arrived off Santiago de Cuba on June 20, 1898, and remained in the vicinity, laying in by day and cruising by night, and started to unload at Daiquiri on June 24, 1898.

One horse died during the voyage. The horses were landed by being thrown overboard toward shore, and landed in the surf. Two horses were drowned in landing, the rest landed safely, and picketed near the shore under guard of a commissioned officer and one platoon of the battery. On the night of the 25th the battery furnished two outposts, one between the cliffs and the seashore, and the other on the road to Siboney.

On June 26, 1898, the guns, ammunition, and equipments were unloaded from the transport *Iroquois*, the battery was hitched in, and we marched to Siboney and camped in a cocoanut grove for the night. Early the next morning we marched on to Sevilla, where we camped till the morning of July 1, 1898, when we moved out, leaving behind the battery wagon and forge. We took position on the left of Light Battery A, Second Artillery, Capt. G. S. Grimes commanding, on the hill above El Poso, and opened fire on the trenches and blockhouse of San Juan. Four shots were fired by the battery when the United States forces were observed going up the hill on which the blockhouse was situated, and the order was given to cease firing.

That afternoon at about 3 p. m. we were moved up to a hill in rear of San Juan, where we dug gun pits and held ourselves in readiness to support our forces if compelled to withdraw. While on this hill we were subjected to an unaimed infantry fire, but no casualties occurred.

We remained there until about 3 a. m., July 2, 1898, when we were ordered to go forward to the crest to the right of San Juan blockhouse. We arrived there at about 4 a. m. and started to intrench, but were able to dig but a shallow pit before daybreak, when at about 5 a. m. we opened fire on the city of Santiago. Our smoke hung in the air, obscuring our view absolutely, and we were instantly subjected to a strong infantry fire from the Spanish trenches. Capt. C. D. Parkhurst, Second Artillery, the battery commander, was wounded early in the fire, and Private Wass soon after. We kept up a fire, frequently using canister and shrapnel cut at zero against the locality from which the infantry fire seemed to come, and occasionally throwing a shell in the direction of the city. We were under fire of the enemy's artillery also, one gun being struck without serious damage, and one horse being killed by it. Our fire was unaimed and the results could neither be observed nor ascertained, as our view was absolutely obscured by our own smoke. After something less than an hour we were ordered by Maj. J. W. Dillenback, Second Artillery, commanding Light Artillery Battalion, to cease firing and bring the guns down by hand from the crest, limber up, and move to the rear. This was done under my command, and the battery moved back on the road toward El Poso. I was leading the battery when we were stalled in the ford of the San Juan River. While waiting there Private McCoy was wounded, it was reported, by a sharpshooter in a tree. Soon after I was detached, by Major Dillenback's order, to stop Captain Capron's battery, coming up with General Lawton's division. On the way I met First Lieut. Ernest Hinds, Second Artillery, on foot, coming up to join the battery. Captain Capron was far in the rear, it was reported, and as there was no commissioned officer present with my battery I returned with Lieutenant Hinds to where it was and turned over the command to him at about 8 a. m. July 2, 1898.

I desire to report by name Sergt. John O'Brien and Corpl. William Underwood for their coolness and courage in serving their guns under fire, and Lance Corpl. William R. Logan, who, though seriously ill, persisted in staying by his gun till compelled by weakness and nausea to withdraw.

Very respectfully, your obedient servant,

DWIGHT E. AULTMAN,
Second Lieutenant, Second Artillery.

NEW LONDON, CONN., September 12, 1898.
The ADJUTANT-GENERAL U. S. ARMY, *Washington, D. C.*

SIR: I have the honor to submit the following report upon the service of my battery (F, Second Artillery) during the months of June and July, covering the expedition to, and operations about, Santiago de Cuba:

1. The horses, men, personal baggage, and camp equipment of the battery were loaded on the transport *Berkshire*, in connection with Battery A, Second Artillery, prior to June 13, 1898, and the transport hauled out into the stream; but the ship came into the slip again and the horses were unloaded and sent up to camp, awaiting the final departure of the expedition.

On June 13 the horses were reloaded, and the transport hauled out and proceeded to the lower bay to await the assembling of the fleet.

The guns, carriages, caissons, harness, and general battery equipment had all been previously loaded and stowed, in connection with Battery A, Second Artillery, upon the lower afterdeck of the transport *Iroquois*, it being possible to load and stow without dismounting any of the battery. The ammunition, and also that of Battery A, Second Artillery, was all stowed, under my personal supervision, in the forward lower hold of the same transport.

It is to be regretted that it was impossible to have loaded the complete battery upon any one transport; but owing to the character and arrangements of these transports, taken as they were where they could be found, such an arrangement was impossible. On the *Iroquois* there was room available for guns and carriages, but none for the horses. On the *Berkshire* horses and men could be taken, but there was no room for guns, etc. Hence, the separation of the men and horses from the guns, etc., appeared unavoidable, even though undesirable.

On June 14, at about 3 p. m., the fleet had got into position and proceeded to sea.

The trip at sea was without particular incident of interest. Though somewhat crowded, and, from the construction and nature of the transport, without much accommodation in the way of cooking, the men got along very comfortably. They were allowed to occupy nearly the whole ship by day and to sleep anywhere at night. The saloon staterooms were allotted to the non-commissioned officers. There was no sickness, and, so far as the men were concerned, nothing better could have been expected under the circumstances.

As to the horses, they stood the confinement and heat of the horse deck much better than had been anticipated. It was to be regretted, however, that the horse deck, being of iron, necessitated a temporary wooden coverning upon which to fasten the stanchions for the stalls and the cleats to prevent slipping. This wooden covering and the cleats formed a regular openwork grill, into which chaff and manure would pack in spite of all efforts to the contrary. The build of the ship, too, was such that no gangways could be provided in rear of the horses, there being barely room for one gangway at their heads; hence the manure was difficult to be got at and removed. All of this made it next to impossible to keep the horse deck as clean as it should have been.

As there were but two small scuppers—one on each side—on this deck, and as the deck was said not to be tight and the hold beneath was full of cargo, no cleaning by flushing out with hose was permissible.

The ventilation was defective, but through the fault of no one, being the best possible from the construction of the ship. Fresh air was admitted through the large wind sails in the forward hatches, and also through the deadlights upon each side of the ship. The side ports, one forward and one aft on each side of the ship, were so constructed that they could not be opened generally with safety; hence there was no proper exit for the foul and heated air, or any chance to cause a strong draft throughout the horse deck.

The small side ports, or deadlights, were quite numerous, and could generally be kept open. They were fitted with extemporized hoods of tin, made by the battery blacksmith, and, with these hoods, admitted a good deal of fresh air while the ship was under way.

By shifting the horses about continuously in a regular order, so as to bring them all in turn into the cooler and fresher part of the deck, they were kept in fair condition, with but one or two exceptions. One horse became sick and exhausted, and died; another was about gone when we were ready to unload, and died before reaching the shore, and another was overheated, and drowned from spasms while swimming ashore. With these exceptions, the horses were landed in very fair condition.

It is to be understood that no criticism or fault-finding is intended by the above report as to the horse deck. It is well known and understood that transports had to be taken as they could be found and the best possible use be made of them. It is not to be supposed that a vessel built for a horse transport would have the many faults of the *Berkshire*, but horse transports were not to be had, and it is fully conceded that the best possible arrangements were made to convert the *Berkshire* into a transport upon which horses could be sent with but small risk of disaster.

The same is to be said as to the limited arrangements for cooking and messing for the men. The *Berkshire*, from her build and previous trade in the merchant service, had simply a forward galley of size commensurate for her limited crew, and aft a small pantry for a limited number of passengers; hence nothing better could have been provided.

As the men had travel rations, the main thing was to provide coffee. This was arranged for by the provision of some large barrels with a steam coil within, in which barrels the coffee could be made by steam heat. By amicable arrangements with the ship's cook and captain I obtained the use of the cook's galley when not in use for the crew, and by cooking at night was thus enabled to give the men extra food above the travel ration from stores brought along for the purpose.

Taken all in all, the trip by sea was by no means a great hardship; the men were cheerful and contented; there was no sickness, and nothing happened to in any way mar the success of the expedition.

II. After arriving at the coast of Cuba the artillery was not landed for a day or two after the infantry had about all landed. Finally the order was received, and the *Berkshire* moved in and anchored within about 400 to 500 yards of the beach.

Contrary to the teachings of the books, the horses would not swim ashore unaided. At first they were sent overboard loosely, expecting that they would swim ashore; but this was at once found to be an impracticable method, for they would swim back to the ship, or to sea—anywhere but ashore.

Consequently the ship's boats had to be used to tow the horses ashore, or to the edge of the surf, and then to drive them ashore, or keep them from swimming to sea. But two horses could be taken at a time, and this made many trips; especially tiresome because of rough water, and because even then, when turned loose, some of the horses refused to go ashore and had to be caught up and again brought back.

The ship's crew was but limited in number, and could not manage the boats all day. They were assisted as best possible by detail of men from the batteries. But soldiers are not necessarily sailors, or, as a general rule, taught a sailor's duty, even in rowing a boat; hence the men available for boats' crews were but few in number, greatly handicapping us in this work. We did the best we could, everyone working faithfully and zealously to get done with a long, tedious, and hard job.

As it was my fortune to be one of the last to unload my horses, I could profit from observation. I therefore sent a trumpeter and a heavy detail of men ashore, some of whom were fearless swimmers. By this means I got my horses ashore without much trouble. After they were turned loose from the boats the trumpeter would sound some familiar call and the men would rush in to catch up some horse about to turn back, frightened by the surf. The trumpet appeared to attract their attention and give them confidence, and a bunch of horses being purposely kept in sight on the beach, the most of them would come through the surf to the trumpet to join those in sight.

Unfortunately, as I began unloading late in the afternoon, darkness prevented its full accomplishment that day, and it had to be finished the next morning; but the last horse was unloaded and all in camp at the picket line before 8 a. m.

After the horses were all on shore one-half of the battery was sent on shore under the orders received to care for them, the rest being held on board to be available for unloading the battery whenever this became possible.

On June 25 a boat came alongside to take the men to the *Iroquois* for this purpose. I went in charge of my men, and the unloading was begun at once.

Everything had to be hoisted up through the hatches and lowered onto the barge alongside. This was successfully accomplished by my battery in exactly one hour and three-quarters. On this barge was Battery A, Second Artillery, as well as my own, and everything belonging to the battery equipment, except the ammunition, was unloaded on June 25. There was no room for this ammunition after the two batteries were unloaded, and, furthermore, a tug came along to take the barge to the dock just as the loading of the harness was completed, and would not have waited for any further loading; hence the ammunition was not touched. It is to be remarked that all of this unloading by my battery was with my own men, assisted by the first and second mates of the ship and wholly unassisted by any stevedores.

By daylight on June 26 a detail was sent to the *Iroquois* to break out and begin loading the ammunition on the barge to send ashore. This barge had been sent back to the *Iroquois* some time during the night, after the batteries had been unloaded from it to the shore. It was long after dark before I finished unloading my battery to the shore, as I was prevented from working except when the track was clear from its then use in unloading small arms ammunition from small boats. The officer in charge of this work permitted me to unload so long as such unloading did not stop his work; hence there were times when I had to wait and do nothing, waiting for the one track and only road to be clear to permit me to run a gun or a caisson on shore

This is only mentioned as a sample of the difficulties under which we worked.

On June 26, while one detail was at work unloading ammunition from the *Iroquois* the rest of the men on the *Berkshire* were hard at work stowing away and arranging the property to be left back and packing up their own kits and rations preparatory to going ashore. While so engaged, a steam launch came alongside and General Shafter in person ordered everybody and everything on board said launch to go on shore.

It is not the place here to mention what transpired before we got on shore; that can be made the subject of a special report if necessary. Suffice it to say that finally the ammunition came on shore, and everyone went zealously to work to load up the battery with ammunition, draw rations and forage, and get in shape to move to the front.

The battery was in shape and pulled out by 3 p. m , June 26, and marched to within a short distance of Siboney, and there bivouacked for the night.

On June 27 we were again on march shortly after daylight, passed by Siboney, and thence on to the front, camping near General Wheeler's headquarters beyond Sevilla. June 28, 29, and 30 were passed in this camp.

On June 29, in the evening, orders were received to be ready to move at a moment's notice in the morning. At daylight, July 1, we were therefore harnessed up and ready to move. At about 7 a. m. orders were received to proceed to and report at General Shafter's headquarters at the front. This order was complied with, and my battery, in company with Battery K, First Artillery (Captain Best's), was parked just off the road near these headquarters, and were held in reserve for some hours, the exact time not taken. Finally, about noon, orders were received to move to the front. We then proceeded to and took position upon the hill near El Poso.

From this position we could see San Juan Hill, and we were given it as our objective. Captain Best's battery, on my right, followed by my battery, opened upon the entrenchments and so-called blockhouse upon the extremity of the hill, all clearly to be seen from our position.

At this time our own line of infantry was clearly to be seen lying down near the foot of San Juan Hill, and the enemy's fire was plainly seen with field glasses coming from the entrenchments and blockhouse.

My first shot was fired with a range of 2,450 yards, and was plainly seen to land in the enemy's entrenchments; following this with another shot, at 2,475 yards, the shell again landed beyond the first, but in the entrenchments; the next shot, at 2,500 yards range, hit the blockhouse, and my last shot, at the same range, also hit the blockhouse. This firing was slow and deliberate, to be sure of the right range, and every shot was carefully watched to see it land; hence the knowledge as to just what each shot did.

In the meantime Captain Best's battery also landed four shell in the intrenchments. I had obtained the range at which he intended to fire and purposely increased it so as to shoot and hit in some place beyond. These eight shots were all that were known to have been fired, as Captain Grimes' battery, on the right of Captain Best's, was busy in refilling ammunition chests at the time, and was not firing.

After my fourth shot I received the order to cease firing, and running out of the smoke again to get a clear view, I saw with my glasses, and also with the unaided eye, that our infantry had rushed upon and captured the position, and were swarming about the blockhouse. As I had stepped back into the smoke to reload after the fourth shot, and was busy reloading, I did not see the enemy abandon the position, nor our infantry when they made the charge up the hill. But it was all apparently done in but the few moments required of me to superintend the loading for the second round, the signal "cease firing" being given within but a moment or two after my last shot.

Our infantry having captured the extremity of the hill and the blockhouse, there was no further firing possible at this objective.

Orders were at first received to prepare for camp in this position upon El Poso Hill, and they were made accordingly. The guns were put in better position, the caissons parked under the protection of the hill, and a picket line was being prepared for the horses.

Before this was finished, however, orders were received to move up to the front and take position with Captain Best's battery, which had been previously moved to the front, and had gone into action from the top of San Juan Hill.

The battery was at once moved to the front, but before arriving there word was received to take another road, leading us finally to a ridge in rear of San Juan Hill. Here Captain Best's battery was found upon this ridge, and my battery went into position upon his left

The name of this ridge is unknown. It had evidently been the scene of an engagement earlier in the day, as dead bodies and spent shells were found upon it. Upon its crest to the right was a house, and near my position were two large iron cauldrons with a pipe line leading thereto. Under the hill was another house, in which were some of our killed and wounded, and behind it a small clearing in the woods, within which our horses and caissons were located.

From this ridge it was impossible for our guns to be of any service. San Juan Hill was higher and but a short distance in our front, and completely hid the enemy. Consequently nothing could be done from this position.

The battery remained in this position until shortly after midnight, and was then moved forward to the crest of San Juan Hill at its right-hand end, and there took position in company with Battery A, Second Artillery, on my right, and Battery K, First Artillery, on my left. Infantry rifle pits had been dug upon the crest of this ridge, and we were ordered to dig gun pits and be ready to bombard Santiago by daylight.

These gun pits were dug, and the guns were in position according to orders long before daylight.

As daylight opened and it was just about light enough to distinguish Santiago in the distance, the enemy opened fire upon us in our front, and the batteries replied with a fire of canister as long as it lasted, and then in my battery with shrapnel cut to zero. It was perfectly evident that the enemy had advanced, during the night or early dawn, under cover of the undergrowth and jungle that covered the Santiago side of San Juan Hill, and from this cover was pouring in a tornado of lead.

Within a very short time after the opening of this fire I was twice wounded, and after the second wound, which broke my arm, was taken to a dressing station under the hill.

After having my arm dressed, and being unable to go back to the battery, I remained at my dressing station until the firing was over.

From my position I could and did watch the burst of shrapnel from the enemy's guns. This shrapnel fire was all, or nearly all, too high, and with fuses cut too long, as it all burst beyond the crest of the hill where the batteries were placed. The bursts were about on a line with the dressing station; hence the fragments all passed beyond, and no fragments were heard to strike anywhere near us. Their only effect was to make the road from the rear dangerous to those advancing.

After the firing was over I proceeded to the rear to the division hospital, had my arm dressed, and from there was sent to Siboney. At Siboney, finding the hospital crowded, I was sent on board the *Iroquois* with a party of officers and men able to travel, and proceeded to Key West, and from Key West to Port Tampa, and thence home upon leave of absence. Hence I am unable to give anything further as to the operations of my battery.

Very respectfully, your obedient servant,

C. D. PARKHURST,
Captain, Second Artillery, Light Battery F.

HEADQUARTERS BATTALION SIEGE ARTILLERY,
Before Santiago de Cuba, July 15, 1898.

ADJUTANT-GENERAL U. S. ARMY, *Washington, D. C.*
(Through military channels.)

SIR: I have the honor to report that on the termination of the truce between the two armies July 10, 1898, this battalion, consisting of batteries G and H, Fourth Artillery, was in action with the enemy before Santiago de Cuba. Fire was opened at 4 p. m. from four 3.6-inch mortars. Nineteen shrapnel were expended.

There were no casualties in the battalion.

Very respectfully,

WILLIAM ENNIS,
Captain, Fourth Artillery, Commanding.

* * *

PROFESSIONAL NOTES.

ORGANIZATION AND ADMINISTRATION.

The Argentine and Chilean Armies.

ARGENTINA.

Troops of the line, including officers	14,000
Year 1877 (in active service for the past five months)	6,588
Earlier years (1891-98) formerly of the active army, now of the National Guard	15,000
Police with military instruction (minimum)	9,000
Year 1877, with two months instruction (called out October 1)	10,853
Year 1876, with two months instruction	14,902
Year 1875, with two months instruction	22,116
National Guard, with 4 years Sunday instruction	80,000
Total	172,459

CHILE.

Troops of the line, including officers	9,000
Earlier years (1891-98), formerly of the active army, with 2 years service	10,000
Mobilized during the revolution of 1891	4,000
Police with military instruction	5,000
Year 1878, with three months instruction	32,000
Years 1876 and 1877, with two months instruction	25,000
Former candidates for commissions, now reserve second-lieutenants of the active army	2,400
Total	87,700

In the practical instruction of the Chilean army great economy was exercised; particularly in target practice, in which Argentina allowed eight times as many rounds as Chile.

THE NAVIES OF ARGENTINA AND CHILE.

The following table contains the names of the warships and their offensive power, represented by the number and caliber of guns, etc.

All ships, which, on account of their condition, their guns or for other reasons, are not of importance in battle, are omitted.

Moreover, no auxiliaries, which may prove problematical or can be used only in harbors, are considered.

Name.	Tonnage.	Armament.				
		Guns of 15 cm. and over.	Guns of 12 cm.	Guns of under 12 cm.	Mitrailleuses.	Torpedo Tubes.
ARGENTINA.						
San Martin	6840	14	6	22	2	4
Garibaldi	6840	12	6	20	2	4
Belgrano	6840	16		22	2	4
Pueyrredon	6840	12	6	18	2	4
Brown	4268	10	4	8		2
Libertad	2336	2	4	4	4	2
Independencia	2336	2	4	4	4	2
Buenos-Aires	4780	6	6	22		5
9 de Julio	3570	4	8	24		5
25 de Mayo	3200	2	8	24		5
Sarmiento	2850	1	4	8	6	2
Patagonia	1442	4	2	10	7	
Patria	1070		2	6	2	5
Espora	520			7	2	5
Misiones	280			6		3
Entre Rios	280			6		3
Corrientes	280			6		3
Py	210			3		3
Murature	110			3		3
Total	54792	85	60	223	33	64
CHILE.						
O'Higgins	8500	14	4	20	4	3
Esmeralda	7020	18		10	4	3
Prat	6900	4	8	20	5	4
Cochrane	3500	6		8	7	3
Huascar	1800	2	2		3	
Blanco Encalada	4400	12		22		5
Zenteno	3600	8		14		3
Presidente						
Errázuriz	2080	4	2	4	6	3
Pinto	2080	4	2	4	6	3
Lynch	750			7	2	5
Condell	750			7	2	5
Molina	1200		4	10	2	5
Simpson	812		2	4		3
Orella	300			6	6	2
Gamero	300			0	6	2
Serrano	300			6	6	2
Riquelme	300			6	6	2
Total	44592	72	24	154	65	52

—*Allgemeine Schweizerische Militärzeitung*, March 4.

ARTILLERY MATERIAL.

The 5-Inch Howitzers at Omdurman.

The last issue of *Engineering* contains some very interesting particulars culled from the *Proceedings of the Royal Artillery Institution*, as to the performances of the 5-inch howitzers which wrecked the Mahdi's tomb at Omdurman, this being the first occasion on which high explosives have been fired in actual warfare. These weapons fire a shell weighing 50 pounds, and in those used at Omdurman, the bursting charge was 4 pounds, 14 ounces, of lyddite. The new shell now supplied, however, contains 9 pounds, 15 ounces of this explosive, and has been proved to be still more effectual than its predecessor. The latter is 3.2 calibers long, whilst the new shell is 3.65 calibers in length. In Egypt the gun was "horsed" by eight mules, the weight hauled being 45 cwt., inclusive of two rounds of case over and above the proper equipment of the gun. These mules are fitted with pack saddles, so that, once the guns were in position, the team could be used for bringing up the ammunition, one mule being able to carry four shells or two boxes of cartridges. With this arrangement for transport, a good fire could, it was stated, be maintained, even when the ammunition base was as much as two miles from the gun. The cartridge used is loaded with cordite, and the charge can be varied with great ease. This is often necessary, though it was not done at Omdurman, owing to the fact that the direct-action fuze, with which the shell is fitted, will not act with certainty unless fired at an angle of 10 degrees, the range with the full charge being then 2000 yards. At Omdurman the ranges varied from 3,200 yards down to 1,250 yards, the former requiring an elevation of 18 degrees, and the latter one of 6 degrees. At the shorter range there were some blinds, the shell failing to explode. The new shells are, it was announced, to be fitted with a fuze, which bursts on graze. The difficulty in arranging this lies in securing the safety of the gun detachment in case of "prematures" in the gun. This difficulty has now, it seems, been surmounted, and the shells will burst on striking horizontal ground after being fired from an elevation of 2 degrees only. The fuze actually used at Omdurman, though failing in the respect named, proved in other respects very satisfactory, and the detachment were able to stand up to the gun with as much confidence as if firing common shell. The hole blown in the dome of the Mahdi's tomb by the shells measured 20 feet in height by 12 feet in width, the walls being 2½ feet thick. Single shells again blew holes through the citadel walls, which were 12 feet to 20 feet high, 6 feet thick at the bottom, and 4½ feet at the top. The gunboats were able to fire down the main street, through one of the holes thus made. In some cases, with walls only one foot thick, the shells got through before bursting; the moral effect then seems to have been very great. The space covered by the fragments of shell in bursting is very large, and General Brackenbury stated that with an 8-inch howitzer at Okehampton a fragment of shell which had burst 2000 yards away, came back amongst the gun detachment. At an experimental firing at Cairo a range party stationed 1000 yards from the target had to move, being still within the danger zone. The head and base of the shell each break up, it is stated, into four or five fairly large pieces, whilst the walls fly into much smaller fragments. Against unsheltered men a battery of 15-pound field guns firing shrapnel is, it is stated, more effective than a battery of these howitzers, but the latter are much superior when the men are behind cover which shrapnel is unable to search out. Lyddite has now been fired from guns of as much as 10-inch in diameter, and the fuze adopted is so safe that even with black powder as the propellant, there has never been a "premature."

—*United Service Gazette*, March 4.

MILITARY GEOGRAPHY.

The Railway Systems of Central and South America.

INTRODUCTORY.

The inauguration of the great Intercontinental Railway project in 1890 will doubtless be readily recalled by most of the readers of *Engineering News*. As planned, the scheme was to connect the principal countries of the two continents of America by a trunk line of railway some 10,300 miles long, of which over 5,400 miles were to be constructed. At that time, indeed, such was the powerful patronage with which the project was started, it did not appear so very incredible to many that this line would be built in the near future. Within a couple of years, however, the project dropped completely out of sight as far as the general public was concerned : and it was only by an effort of memory that even engineers recalled that a commission still existed and was ostensibly at work in the interest of the scheme. Such, however, was the fact; and this Commission has just published its final report, comprising seven thick quarto volumes, which traces the history of the project from its inception until the fall of 1898.

Briefly described, the work which has been done is to make a preliminary survey for the proposed line at a cost of $288,588, including the amount expended in printing the final report.

Despite the effectual manner in which time has buried the project for an Intercontinental Railway, a history of its inception, and of the work which the Commission has done in the field will, we think, be of interest to many. The surveys were carefully and intelligently conducted reconnaissances, and much of the information of various kinds developed by them is such as will appeal to engineers and others interested in the present and future railway development of Central and South American countries. In these respects the report is worthy of mention, and an abstract of its principal contents will be quite in place in these columns. In order that this abstract may be fully intelligible, we have replotted to smaller scale, or have reproduced in full, the principal elaborate general maps of separate countries, which the report contains. These maps show fully the existing and projected lines, and the new surveys which go to make up the route of the Intercontinental Railway as projected by the Commission.

Of the two classes of railways shown, however, the local lines already built are of considerably the most importance in the present status of the Intercontinental Railway project. The information regarding these embraces the very latest facts obtainable upon the subject up to the time of the printing of the report. Regarding the maps which are reproduced direct in Figs. 1 and 3, it should be stated that they are not tracings of others already in existence, but were plotted direct by the Commission's engineers. The reports made by the field survey parties sent out by the Commission furnished the data for the belt adjacent to the line of the survey, but for other portions all known accessible maps and reliable authorities have been consulted. The map shown in Fig. 2 has been traced from an atlas map of South America to bring the scale down to a point where the map could be used in these columns.

HISTORY OF THE INTERCONTINENTAL RAILWAY COMMISSION.

In May, 1888, a bill passed Congress and was signed by the President, authorizing the calling of an International Conference of the American republics at Washington for the purpose of promoting closer commercial and business relations between them. The delegates of the several countries convened at Washington, D. C., on October 2, 1889, and on February 26, 1890, the Committee on Railway Communication submitted a report, in which it urged that "a railway connecting all or a majority of the nations represented in the conference will contribute greatly to the development of cordial relations between said nations and the growth of their material interests," and also recommended that "the best method of facilitating its execution is the appointment of an International Commission of Engineers to ascertain the possible routes, to determine their true length, to estimate the cost of each, nd to compare their respective advantages." This report was taken up and advocated by Hon. James G. Blaine, the father of "Pan American" things in general, and through his advocacy the act making appropriations for the diplomatic and consular service of the United States for the fiscal year ending July 30, 1891, contained a provision appropriating $65,000 as the share of the United States towards preliminary surveys. The act also authorized the President to appoint the necessary engineer commissioners.

The Intercontinental Railway Commission, having thus been called into existence, began work on December 4, 1890. After organization, the Commission turned its attention promptly to the main business of carrying out the preliminary surveys. The money available was $133,000, of which the United States had appropriated $130,000, and Chili $3,300. Argentina, Mexico and Uruguay declined to contribute money toward the surveys, but proposed to complete the railways each in its own territory to connect with the Intercontinental line. It was decided that the finances would warrant the sending of only three corps of engineers into the field, although the Committee on Surveys had laid out work for six corps.

Organization of Surveying Parties.—It was planned that Corps No. 1, composed almost entirely of officers of the U. S. Army, under the command of Captain E. S. Steever, U. S. Army, was to proceed to Central America and survey a line from the western boundary of Mexico through Guatemala, Salvador, Honduras, Nicaragua, and Costa Rica; then through the Isthmus of Panama into Colombia until it should meet Corps No. 2 coming northward. Corps No. 2, under the direction of Mr. Wm. F. Shunk, was to proceed to Quito, Ecuador, and thence survey northward to Colombia, and through that republic and the Isthmus of Panama until it should meet Corps No. 1 coming from the north. Corps No. 3, under Mr. J. Imbrie Miller, was to proceed to Quito and thence survey southward through Ecuador and Peru to Lake Titicaca, on the confines of Bolivia.

As already stated, these three parties were the only ones actually dispatched to the field, but the scheme of the Committee on Surveys included three other parties which, if the finances permitted, were to be sent out at a later date. Corps No. 4 was to enter the field by the way of Antofagasta, Chili, and proceeding northeast, was to begin its surveys near the city of Oruro, Bolivia, working towards La Paz, Bolivia, and Puno and Cuzco, Peru, until it should meet Corps No. 3 coming southward. Corps No. 5 was expected to commence its surveys at Huanchaca, Bolivia, and work to the neighborhood of Potosi, crossing the river of Pilcomayo, entering Brazil by the way of Corumba and extending its surveys via Coxim until a connection should be made with the railways running to Rio Janeiro. Corps No. 6, commencing its work at Potosi, Bolivia, was to follow the course of the Pilcomayo River and proceed toward Asuncion, Paraguay, thus making connection with the railways of that republic and Uruguay.

The instructions issued to the surveying parties were that the general route laid out by the Commission should be followed, and that the surveys should be made sufficiently in detail to obtain "the data necessary for the preparation of a topographical map of the route and the location thereon of the lines selected, and for making a profile of the same." To this end notes were to be taken of: (1) the general topography of the region traversed. (2) Their general geological formation. (3) The nature of the soil, climatic conditions, and of the character of the agricultural and other industries. (4) The population. (5) The materials available for railway construction. The general route selected by the Commission was followed substantially as laid out, and is shown by the accompanying maps. After setting the surveying parties at work, the Commission took a final adjournment, first, however, appointing an executive committee, to which it delegated the necessary power and authority to carry to completion the work projected. Attention may now be turned to the information brought out by the work of the different surveying parties.

WORK OF SURVEY PARTY NO. I.

Guatemala.—The proposed line lies west of the Continental Divide. The peaks, generally volcanic, forming the crest of the divide, send out long, slender spurs toward the Pacific. These spurs rapidly decrease in altitude, and sink into the plain level before the coast is reached. Between these spurs are streams running almost perpendicular to the seaboard, and, consequently, a railway whose general direction is from west to east must cross these spurs and streams nearly at right angles. A glance at the map shows the frequency of these streams.

The existing railway lines are shown by the solid lines on the map, and briefly described, they are as follows: Beginning at the open roadstead of

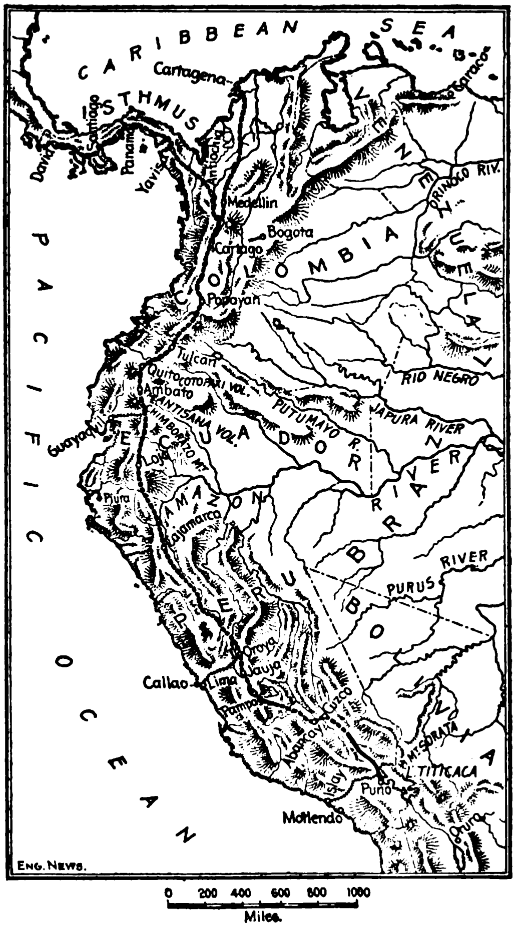

FIG. 2.—Map of Northwestern Portion of South America, Showing Existing and Projected Railways and Route of Intercontinental Ry. Survey.

—By courtesy of *Engineering News.*

Ocos, a narrow gage line has been built to Ayutla, between 12 and 15 miles distant, and an extension is projected to Coatepeque, and possibly to San Marcos. The next line in order proceeding east extends from the port of Champerico, via Caballo Blanco and Retalhuleu, to San Felipe, a distance of 41 miles, with a projected extension of 41.5 miles from Casa Blanca, 2 miles from San Felipe, via Zunil, to Quezaltenango. It is known as the Guatemala Western, and is a narrow gage road. From the port of San Jose the Guatemala Central Railroad is in operation to Guatemala City, a distance of 74 miles. From Guatemala City an extension is projected down the valley of the Rio de las Vacas, via Panajach, to Rancho de San Agustin, a distance of about 62 miles, the exact distance depending upon the route finally adopted. The surveys have been completed and some grading has been done. From Guatemala City to Panajach the elevation to be overcome is about 3,600 feet in from 30 to 32 miles of line, but the remainder of the grades to Rancho de San Agustin are easy. At the latter place connection is made with the Guatemala Northern Railway, which is in operation to Puerto Barrios, 134.2 miles distant. Both the Guatemala Central and Guatemala Northern are 3-feet gauge lines. The former has a branch extending from near Masaqua to near Patulul, 33.3 miles. There is also built and in operation on the Atlantic slope a railway from Tecuru to Panzos, 22 miles long, and an extension has been projected to Coban, but its early construction is doubtful. The proposed links of the Intercontinental Railway joining these lines are shown by the full lines on the map. Altogether 126.9 miles of new line would be required.

Salvador.—The physiography of the Pacific slope of the divide is much the same as that described for Guatemala. The principal river of the country is the Lempa. The principal existing roads built and projected are as follows:

The National Line is built and in operation from Acajutla, via Ateos, to Ceiba, a distance of 41 miles, whence a diligence runs to Santa Tecla, from which a tramway extends to San Salvador, 7 miles. From Ateos the Santa Ana Railway is built, via Sitio del Nino, to Santa Ana, a distance of 66.6 miles from Acajutla. There is also a branch now in operation from Sitio del Nino to Nejapa, 12.4 miles, whence a diligence runs to the capital, 12 miles further. A portion of the line between Nejapa and San Salvador is under construction. From La Union to San Miguel, 20 miles, a line has been graded and 10 miles of track laid. A line is also projected from La Libertad to San Salvador, and surveys have been made for a line from La Libertad to Santa Tecla, upon which construction is to be soon commenced. The mountain sides are to be ascended by six switchbacks. The gauge of all the railways of Salvador is 3 feet. The route of the Intercontinental Railway, in relation to these existing lines, is shown by the broken line, and as projected between Hachadina and Rio Guascoran, 166.8 miles of new line would have to be built.

Honduras.—The portion of this country within the zone of the railway examination is in general flat, and offers few barriers to railway construction. "The Gulf of Fonseca is without question the finest harbor on the Pacific coast of America. Its extreme length is from 50 to 60 miles, and its average width about 30 miles. It contains a number of islands, is well protected, and its extent is such that it is capable of sheltering the combined navies of the world."

The only railway of the country at present is the proposed interoceanic line from Puerto Cortez, via La Pimienta, Comayagua, La Paz and the valley of Guascoran, to La Brea or some other point on the Gulf of Fonseca. The first 30 miles to La Pimiento have been completed, and a branch is projected to

Tegucigalpa. An American syndicate (*Engineering News*, October 28, 1897,) has charge of the construction of this line, whose gauge will be 3½ feet. The proposed Intercontinental railway line from Rio Guascoran to Rio Negro is 71 miles.

Nicaragua.—Taken together, the projected and completed railway lines of this country aggregate a considerable mileage. The only line in operation is the Nicaragua National Railway, which may conveniently be considered under three divisions, the western, central and eastern. The western division, from Corinto, on the Pacific, to Momotombo, 57.7 miles, is built and in operation. The central division is not yet constructed, but is intended to run from La Paz Junction, via Nagarote and Mateare, to Managua, 36 miles. At present communication between Momotombo and Managua is maintained by means of steamers on Lake Managua. The eastern division, from Managua to Granada, 32.6 miles, is in operation. A branch of the National line, from Masaya to Diramba, 29 miles, is under construction, and 9 miles were completed in July, 1897, and the remainder was to be completed within a year from that date. The gauge of all these lines is 3½ feet.

Among the projected lines of Nicaragua is one from San Juan del Sur to San Jorge, on Lake Nicaragua, 22 miles, with a branch from Chinandega to El Vejo, from four to five miles long. To bring the central portion of the Republic into communication with the departments in the northeastern section, a road has been projected from Momotombo, via Sebaco and Matagalpa, to a point on the Rio Grande. The distance to Matagalpa is between 90 and 100 miles, and to the Rio Grande from 240 to 250 miles. A more feasible project is that known as the Atlantic, or Rama, railway, which is projected to run from the port of San Ubaldo, on Lake Nicaragua, to the city of Rama, 102 miles. In order to make it a through line, an extension along the northeastern shore of Lake Nicaragua, to connect with the National line at Sabana Grande, has been proposed, the total length of the main line and extension being 220 miles. This route has been examined by competent engineers, and its feasibility demonstrated. The Intercontinental Railway, from Rio Negro to Pena Blanca, as shown by the broken line, would be 209.7 miles long, of which 103.4 miles, between Chinandega and Granada, may be considered as practically finished.

Costa Rica.—The rugged nature of the Pacific slope, with its long mountain spurs and intervening valleys and streams, is more noticeable here than in any of the countries so far mentioned, excepting, possibly, Guatemala. The mountain spurs, however, extend down much nearer the coast than in Guatemala, many of them terminating in abrupt promontories.

There are but two railways in operation in Costa Rica, of which the most important by far is the Atlantic Railway, running from Puerto Limon to Alajuela, 117 miles, with a branch from Siquirres to Carrillo, 25 miles. From Carrillo an extension has been projected, via Muella and the valley of the Rio Frio, to Fuerta de San Carlos, a distance of 25 miles. This extension has been carefully surveyed, and is believed to possess many advantages as a connection between Lake Nicaragua and the Caribbean Sea. Its approximate length would be 100 miles. All the road so far built has a gage of 3 feet 6 inches. The second railway of Costa Rica is an unimportant, narrow-gauge line, 13 miles long, between Punta Arenas and Esparta. It was originally the intention to extend this line to Alajuela, where connection would be made with the Atlantic Railway, but more recent studies have indicated another route as being preferable, namely, that commencing at San Jose and following

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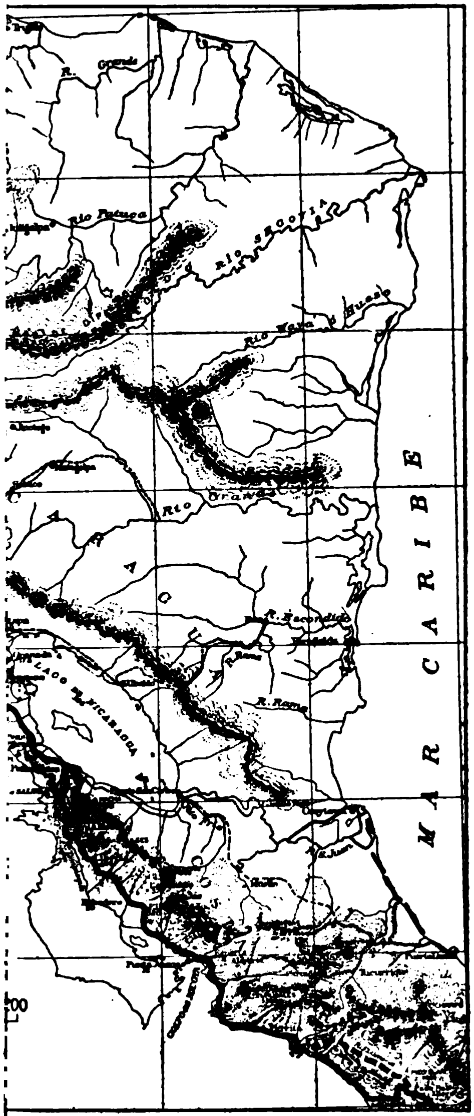

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the valley of the Rio Grande to the plains of Santo Domingo, and thence turning towards the northwest to Punta Arenas, a distance of about 62 miles. The route of the Intercontinental Railway, from Pena Blanca across Costa Rica, hugs the coast closely. The distance to Rio Golfito is 360 miles, all of which would be new line.

The foregoing covers the investigations for the Intercontinental Railway in Central America. Briefly summarized, the total distance from Ayutla across Guatemala, El Salvador, Honduras, Nicaragua and Costa Rica to Rio Golfito, is 1,043 miles, of which 211.3 miles are practically constructed, leaving 831.7 miles to be built.

WORK OF SURVEY PARTY NO. 2.

The two sections of territory covered by the surveys of Corps No. 2 were surveyed in opposite directions—the southern portion from the south northward, and the northern portion from the north southeastward—but for the purpose of summary it will be better to consider the line as running continuously from north to south. As a matter of fact, the work of Corps No. 1 did not extend clear to the Rio Golfito, but only as far as the Rio Savegre, where Corps No. 2 took up the survey.

Colombia.—The western section of this country is a series of parallel mountain ranges, separated by the valleys of the Rio Magdalena, Rio Cauca and Rio Atrato. Following the western coast of the Isthmus of Panama the Intercontinental railway line takes the valley of the Rio Cauca south. At present the main artery of commerce of the country is the Magdalena River, and nearly all the railway lines heretofore constructed have been built to connect the more important centers of trade and population with the waters of this stream which, however, is navigable by vessels of small draft only, having a very swift current and also steep rapids near Honda.

The railway across the Isthmus of Panama was the first one constructed south of the Rio Grade, and, as is generally known, was begun in 1850 and completed in the same year. The Cauca Railway starts at the Pacific seaport of Buenaventura, and, ascending the valley of the Rio Dagua, is completed to a point beyond San Cipriano, about 25 miles. Surveys have been made, and some construction has been done on an extension to the town of Cali, in the fertile Cauca valley. The Antioquia Railway is designed to connect Puerto Berrio, upon the Magdalena River, with Medellin, the capital of the Department of Antioquia, the distance being 125 miles. Only the lower portion of the line from the river to the town of Pavas, about 31 miles, has been finished. This road is in poor condition and not equal to the present demands of trade. The Cartagena Railway, from Cartagena to Calamar, 60 miles, and the Bolivia Railway, from Puerto Colombia to Barranquilla, 18.5 miles, are in operation. The Santa Maria Railway is under construction, with about 37 miles in operation, from Santa Maria, on the Caribbean Sea, to Banco, on the Magdalena River. The Cucuta Railway runs from Villamizar to San Jose de Cucuta, a distance of 34 miles. The Doruda Railway extends from Las Yeguas, at the head of navigation on the Rio Magdalena, to Arrancaplumas, near Honda, a distance of 14 miles. The Girardot Railway runs from the town of that name up the valley of the Rio Bogota, and is completed to Juntas de Apulo, a distance of 25 miles. It is the intention to extend this line to Bogota. From Bogota the Sabana Railroad is in operation for a distance of 26 miles to the town of Facatativa, and it is intended to extend the line to the

Rio Magdalena, at some point in the neighborhood of Ambalema, or Honda. The Zipaquira Railway extends from Bogota to Chapinero, a distance of 4 miles. There is also a railway under construction between Bucaramanga and Puerto Wilches, on the Rio Magdalena, and another is being built between Girardot and Ibague. These comprise all the lines completed, and actually under construction, although several concessions for roads of more or less importance have been granted.

The route of the projected Intercontinental Railway along the western coast of the Isthmus, and thence south through the valleys of the Rio Sucio and Rio Cauca, with a branch from near Paso de Caramanto, north to Carthgena. The total distance from the Rio Golfito to the Rio Carchi is 1,354 miles, exclusive of the Cartagena branch. For the purpose of connecting the main line along the Cauca River with the Magdalena valley and Bogota, two routes over the Codillera Central were more or less examined. The first of these was from Cartago to Ambalem, 130 miles, and the second was from Popayan to La Plata, 100 miles. Briefly summarized, the total distance from Ayutla, on the Mexican border of Guatemala, to the Rio Carchi, near Ipiales, is 2,397 miles, of which 211.3 miles are built and 2,185.74 miles would have to be constructed.

WORK OF SURVEY PARTY NO. 3.

The task allotted to Corps No. 3 was to survey the line from Quito, south, through the principal central towns of Ecuador into Peru, and after striking the Maranon River, in the northern part of the latter republic, to follow its valley to its headwaters, near Cerro de Pasco, and thence proceed southeast towards Cuzco and onward towards the confines of Bolivia.

Ecuador.—Although its surface is very diversified, this country does not present the jumble of mountain passes which is found in certain other parts of South America, but rather a well-defined system. Running from the northeast to the southwest, through the center of Ecuador is an elevated region, situated between two ranges known as the Oriental and Occidental Cordilleras, which are, in general, from 30 to 60 miles apart. Although the axes of these two ranges are not straight, but curved lines, in certain parts there is more or less of a paralleism to be noted. Outside of the main ridges there are projecting spurs extending east toward the Amazon River, and west toward the Pacific Ocean, and the two ranges are more or less closely connected by transverse ridges, which by the natives are called nudos, or knots. These divide the central valley into ten or more compartments, varying in length, breadth and elevation, and it is the passage of these cross ridges within the limits of a suitable alignment and grades that present difficulties to the locating engineers. The floors of these basins vary from 7,000 feet to 10,000 feet above the sea in the north, and the dividing ridges at their lowest points attain altitudes of from 9,300 feet to 11,500 feet, but become considerably lower in proceeding south. Nearly three-fourths of the population of the country is contained in this central valley or zone.

The only railway in operation in Ecuador is the Ferrocarril del Sur, running from Duran, a town opposite the porte of Guayaquil, to Puente de Chimbo, and north. The length of the road in operation is between 55 and 60 miles, and the intention has been to extend from Chimbo, via Sibambe, to the neighborhood of Tigsan, and, ultimately, to continue the line northward across the interior basins to Quito. Some grading has already been done between Chimbo and Tigsan, and, according to recent information, proposals have been invited by the Ecuadorean Government to complete the line to the

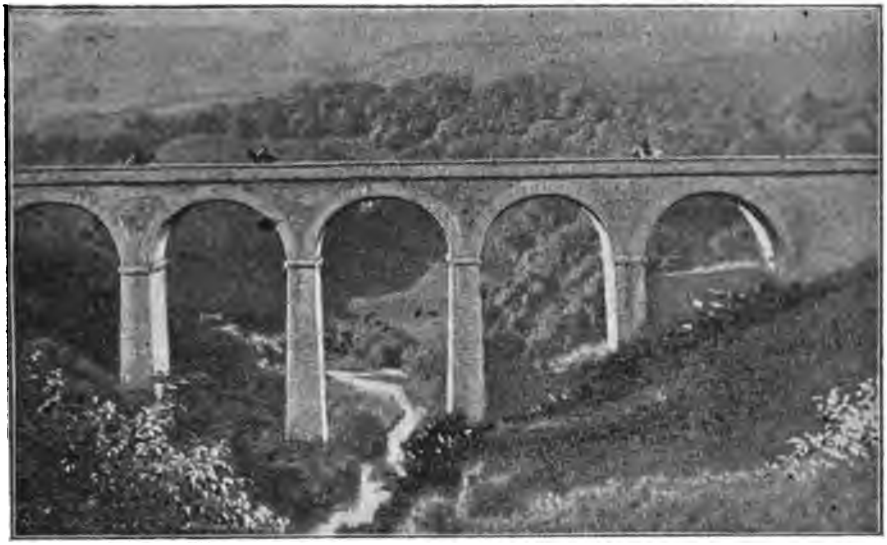

Fig. 4—Jambeli Bridge on National Road near Quito, Equador.
—By courtesy of *Engineering News*.

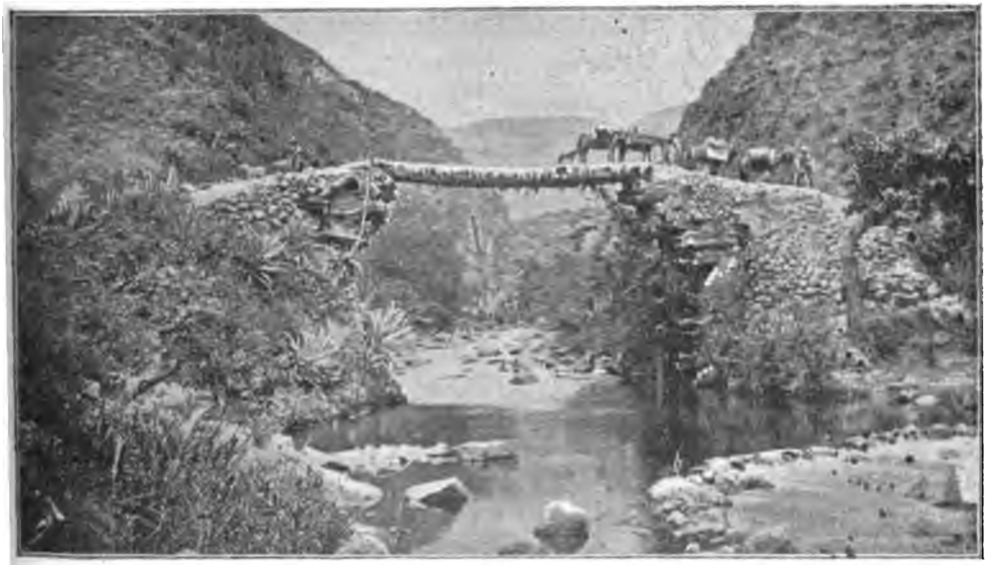

Fig. 6—A Native Cantilever Bridge, Ecuador.
—By courtesy of *Engineering News*.

capital. The distance between Chimbo and Sibambe is only 15 miles in a direct line, but the difference in elevation to be overcome is said to be 7,727 feet, requiring a lengthy development and heavy grades. The route of the Intercontinental Railway across Ecuador, from Rio Carchi to the Rio Canchis, is 658 miles.

Peru.—The railways of Peru are quite notable. Beginning at the seaport of Paita, there is a line in operation up the valley of the Chira to Sullana and thence to Piura, a distance of 62 miles. Private parties have recently extended this to Catacaos, a distance of 6 miles. From Eten and Pimentel, on the coast, there are short lines to the cities of Lambayeque, Chiclayo and Ferrenafe, a distance of 50 miles. The Pacasmayo road, starting from the port of that name, ascends the Rio Jequetépeque to Yonan, with a branch to Guadalupe, the length of the line in operation being 66 miles. Extensions are proposed to Cajamarca and Hualgayoc. There is also a short line from Salaverry through Trujillo to Ascope, 53 miles. Proceeding southward the next railway in order is the Chimbote line, which ascends the Rio Santa, and is completed to Suchiman, a distance of 30 miles. The famous Oroya Railway, built by Henry Meiggs, comes next in order. It extends to Oroya on the Janja River from Callao, a distance of 136.5 miles, and is substantially constructed. From Lima a short line runs southward to the watering place of Chorrillos, a distance of 7 miles. A 48-mile line runs from Pisco, on the coast, to Ica, and a proposition has been made to extend it to Lima.

The longest line in operation in Peru is that which starts at the port of Mollendo, and running, via Arequipa, crosses the Continental Divide at an elevation of 14,665 feet, at the Portezuela del Crucero, thence proceeding via Juliaca it reaches Puno, on Lake Titicaca, the altitude of this town being 12,540 feet. From Juliaca a branch line has been built, via Santa Rosa to Sicuani, in the direction of Cuzco. The distance from Mollendo to Puno is 325 miles, and from Juliaca to Sicuani is 122.4 miles. Surveys and estimates have been made to extend the line from Puno along the shores of Lake Titicaca, via Desaguadero, to La Paz, in Bolivia. To descend from the plateau to the town of La Paz, two systems have been proposed; one an inclined plane, 8,202 feet long, dropping 1,410 feet, using the Ogudio system (rack and rope), at a cost of $170,327; the other a rack road of the Abt. system, with 15% grades, the length being 15,092 feet, and the fall 1,329 feet, costing about $369,854. The distance from Puno to Desaguadero is 102.53 miles.

The route of the Intercontinental Railway, as surveyed to Cuzco, is shown sufficiently by the map. The total distance to that city from Quito is 1,944 miles. The railway lines built and projected between Cuzco and Desaguadero have already been described. To summarize the total distance from Ayutla to Desaguadero is 4,840 miles, of which 362.9 miles are constructed, and 4,447 miles remain to be built.

In concluding this review of the railway system of Peru it may be mentioned that a proposition has been made to extend the Pacasmayo Railroad to Borja, on the Maranon, whence water communication along the Amazon would give access to the Atlantic Ocean. In addition, instrumental examinations have been made of the route from Oroya, via Tarma, near the head of the Chanchamayo River, to the head of navigation on the Perene, with the same object in view.

THE SOUTHERN SOUTH AMERICAN STATES.

While the investigations of the Commissioner's surveying parties extended no further south than Cuzco, its report includes the countries of Bolivia, Argentina, Paraguay, Uruguay, Chili and Brazil. Of these the railway systems of all except Bolivia and Brazil are rather noteworthy, that of Argentina being particularly so, and are worthy of some extended description. The map, Fig. 3, of these countries, is reproduced direct from that in the Commission's report. This map shows the general physiography of the territory so fully that no description is necessary.

Bolivia.—The only railway in actual operation in Bolivia is the narrow gage (75 cm., or 29.52-inch) line, which, starting at the Chilian part of Antofagasta, climbs the Pacific slope of the Andes by the way of Calama and crosses into Bolivian territory near Ollague, north of Ascotan, and thence proceeding through Uyuni and Challapata skirts the eastern borders of Lake Poopo and terminates at Oruro, distant 574 miles from Antofagasta. There is a short branch, 20.3 miles long, connecting Uyuni with Pulacayo, thus affording access to the important silver mines of Huanchaca. It is the intention to extend the main line northward to La Paz in order to put this last point into direct communication with the Pacific coast at Antofagasta, and thus divert some of the trade that now goes to Mollendo by the steamers on Lake Titicaca and the Mollendo, Arequipa and Puno railway in southern Peru. The proposed extension from Oruro to La Paz has already been surveyed and construction has been commenced. The distance is 155 miles.

Surveys have been made eastward, from Challapata to Colquechaca, Sucre and Potosi, the distance to Colquechaca being 62.14 miles, and to Sucre 76.43 miles further. The officers of the Arequipa and Puno Railway have made surveys to extend their line to La Paz, the line being divided into two sections; the first between Desaguadero and the plateau overlooking La Paz would be 66.52 miles in length. For the second section, comprising the descent to the town, two solutions are proposed, as already described in the paragraph on Peruvian railways.

It is proposed to build a railway from La Paz, via Corocoro, to the city of Tacna, where connections would be made with the Arica Railway, already in operation, the distance between the two last-named points being 39.15 miles. This would be the shortest route to the Pacific coast, but would involve some very difficult work in surmounting the Andes, the distance from La Paz to Tacna being 294 miles. At present much of the commerce between Bolivia and the outside world is conducted over this route by means of mules, burros and llamas. Surveys and estimates have been made for a railway by the Abt system from La Paz eastward and northward through the rich province of Yungas to the head of navigation on the Beni River, the distance being from 93 to 124 miles, and the estimated cost $3,893,200. In southern Bolivia investigations have been made to extend the railway from Uyuni to Tupiza, 119 miles, and thence to Quiaca, on the Argentine frontier, a further distance of 55.9 miles. At Quiaca one is within 125 miles of Jujuy, at present the northernmost terminus of the Argentine railway system.

Concessions have been granted for a railway from Oruro, through Cochabamba to Trinidad; also from Cochabamba to Santa Rosa de la Sierra, and thence to Puerto Pacheco, on the Paraguay River; likewise another for the extension of the Paraguayan and Bolivian standard gauge line from Asuncion to Sucre. This is known as the Osborn concession; and a proposition has been made to continue the line, via Oruro, La Paz and along the eastern shore of Lake Titicaca, to Santa Rosa, in Peru, where connection would be mahe with the Southern Railway of that republic, in operation northward as far as Sicuani.

Argentine Republic.—The railway system of this country is the most extensive of any in South America, and only a briet mention of some of its more important features can be made here. In 1857 there were just over six miles of railway in the country, and in 1892 there were 8,071, which has been added to considerably since. The first railway which should be mentioned for its importance is the Buenos Aires and Rosario Railway. This line has a gauge of 5½ feet, and extends from Buenos Aires, through Rosario to Tucuman, a distance of 717 miles. This, in connection with the Central Northern Prolongation Railway, with a gauge of 3¼ feet, carries railway communication to the town of Jujuy, 936.66 miles from Buenos Aires. The second notable line is the Transcontinental System. The first link in this line is the Buenos Aires and Pacific Railway, of 5½ feet gauge, running from Buenos Aires to Villa Mercedes, 430 miles. At the last point connection is made with the Argentine Great Western Railway, having the same gauge and extending to Mendoza, a distance of 221 miles, with a northern branch open to San Juan, a further distance of 97.87 miles. At Mendoza junction is made with the 3¼-ft. gauge Transandine Railway, which is being built to the Argentine frontier, a distance from Mendoza of 107.81 miles, where connection will be made with the Chilian section of the same road. According to the latest reports, the Chilian section was completed eastward as far as Salto de Soldado, there being a gap between that point and the Argentine terminus at Punta de las Vacas of 46.6 miles. Under the concession granted by the Chilian Government in 1895 the excavation of the numerous tunnels of this line is gradually approaching completion. The other railway lines of Argentine, Chili and the republics east of them, as well as the most important projected lines, are shown by the map, Fig. 3.

Editorial Comments by Engineering News.

The report of the Intercontinental Railway Commission, which we abstract as regards its principal technical features in another part of this issue, recalls to mind what was without doubt the most chimerical of all the schemes promulgated by the nearly forgotton Pan-American Congress of ten years ago. Probably no well-informed engineer ever took very seriously this fantastic project to connect all the American republics on the two continents by a government railway; but it was at its inception pushed with such energy by a few active Congressmen and Cabinet members that it certainly came to be regarded by many people as a really meritorious enterprise, whose early consummation was not only desirable but entirely probable. This idea was greatly encouraged by the prominence given by the daily papers to the deliberations of the Commission and to the final dispatching of its surveying parties into the wilds of Central and South America. As some of these papers are now trying to revivify the scheme, it may be well to point out again some of its absurdities, which were obvious at the beginning and which the surveys have served to bring out more plainly.

The cost of the enterprise to date and the amount of valuable work which those in charge of it have to show for this expenditure first deserve notice. During its eight years of existence the Intercontinental Railway Commission has spent $292,452, according to its own showing, of which $192,734 was spent in making the surveys, $65,910 was consumed in office expenses, and $33,808 was the cost of printing the present report. Of this sum the United States contributed about $195,000 in cash and the printing expenses, Brazil contributed $30,000 in cash, and six other Central and South American countries the balance. Argentine, Mexico and Uruguay have lent an encouraging countenance to the work, but, it is refreshing to note, have kept a close grasp on their purse strings. Its surveys are about the only work of the Commission which has served some useful purpose. They were, in general, fairly good reconnoissances of the territory adjacent to the proposed railway line and give a good deal of interesting information regarding the physical geography, natural resources, people and railways, and other means of communication of the countries visited. In these respects we are glad to recommend the report of the Commission as a useful publication.

As far as the Intercontinental railway line is concerned, the surveys also show that to complete an all-rail route connecting the United States with the Latin-American republics as proposed there must be built some 5,400 miles of railway, the cost of which, for grading and masonry alone, is estimated by the Commission at $175,000,000. All equipment and practically all structural material, including tools, cement, and even timber, in many instances, must be shipped into the country from the United States. To sum up, there would finally be a railway line which would not only parallel the ocean routes, but which would actually be much longer from port to port than these ocean lines, and which runs for much of its length south of Mexico through countries with a sparse and semi-civilized population and almost no industries. It is perfectly certain that private capital could never be induced to invest in such a line of railway under such conditions; and no one who takes a reasonable view of the proper functions of government could favor its engaging in such an enterprise, promising neither direct nor indirect profits.

—*Engineer News*, March 23, 1899.

STRATEGY.

The Lessons of the Spanish-American War.

Admiral Colomb read a paper on the subject indicated by the above heading, in the United Service Institution, on Wednesday, March 8, last. Of the war most of our readers have heard enough. Admiral Colomb's deductions, however, are very important, and may concern our future welfare, so that we cannot afford to disregard them. Incidentally we may observe that the paper was exceptionally able and interesting.

The author first discussed the probable reasons why the stronger power—that is, the United States—did not follow the orthodox line of war, a line which, if we recollect rightly, Admiral Colomb has very strongly advocated more than once, that is to say, the watching of the enemy's fleets, having first, to use an American term, "located them." This would have implied the sending of an American fleet into European waters; but it would have prevented the liability to scare and uncertainty that prevailed in America, and prevailed to such an extent that Admiral Colomb says the hampering influence truly assigned by Torrington to the fleet in being, which may attack, is exaggerated greatly, now that such a fleet has steam to depend on, instead of uncertain winds. We may here remark that we are a little surprised that Admiral Colomb did not say more on the absolute dependence on coal supply, and the immense value of coaling stations. We do not know all the reasons that made America thus act locally by operations liable to interference by the attack of the Spanish fleet, insignificant as it was in comparison to her own. Something, however, may be guessed. Admiral Colomb thinks that the political effect of the appearance of American ships in European waters was dreaded. Nothing certainly was more calculated to assist the Spanish in obtaining European support. Moreover, the scene of action being close to America and far from Spain, doubtless carried weight, and the Spanish fleet might soon be localised as it was, but not, as Admiral Colomb thinks, need have taken place, had the Spanish ships and preparations been more efficient, for Cervera had abundance of time to get into Santiago harbor, coal, and get out again before the American fleet closed on him. As to intelligence, the difficulty appears not to have been in obtaining news, but in sifting the grain from the chaff of the most oppressive loads of news poured in day after day. The reporter was on the prowl everywhere. It was very necessary, however, to detect his guesses and theories from real facts and plans. Some interesting experience was acquired as to telegraph cables, and how far they are likely to be interfered with in war. Legally, it appears that it is only on hostile grounds that they can be cut without interference with the rights of neutrals. Thus, the French cable from Cuba to Hayti was in three different conditions in its different parts. Within three miles of the Cuban shore, it was legally open to destruction by America. "From the Cuban three-mile limit to the Haytian three-mile limit the cable was as much French property as any French mail steamer." Within the Haytian three-mile limit French and Haytian rights would have been alike defied by cutting it. The physical difficulties in cutting a cable were found to be greater than were foreseen in deep water, and at the shore end attempts to cut cables were repeatedly defeated by the enemy. So that Admiral Colcomb thinks England would not find it difficult to secure her cables by a small effort to provide the defense at the shore end. We may here add that in a really great war we do not see why the operations resorted to for fishing for a cable broken in deep sea should not be successfully carried out, and though it might entail a heavy charge for infringing the rights of neutrals, it might be provided for in an indemnity paid by the unfortunate vanquished side.

So soon as Cervera was shut up in Santiago, the usual practice of naval war prevailed; that is to say, the American fleet watched the entrance, and the capture of Santiago was determined on. As to tactics, the bombardment of towns was prohibited most properly; some attacks of forts took place, but did not come to much. Admiral Dewey at Manila threatened to bombard the town if the forts did not cease to fire on the ships. Here we would repeat our ofttold conclusion as to firing on towns, namely, that in most cases the town might very well defy the ships to do their worst, for it is seldom indeed that a ship's ammunition would not be worth much more to her than any result she could reap by blowing a few houses about. The key to the question is the very limited quantity of ammunition that a ship can carry. We should have no hesitation, if in a threatened town, in saying Fire away!—the only result to be expected being, in most cases, a very slight loss in property, and still less, if any, in life, with the result that the ships would be pinched, as far as they dare go, for ammunition, and would bring on themselves the disgrace of a savage inhuman operation. Admiral Colomb finds evidence that forts grow obsolete as quickly as ships. This, we think, is too strong. Doubtless, as ships get better protected more powerful guns are needed, and quick-fire calls for increased protection, but these are only two elements among many which belong to ships. In the actual fighting Admiral Colomb finds a more savage spirit prevailing than was to be expected—ships get actually destroyed instead of being overpowered and captured. In closing, we regret that we are obliged to give such brief notice to so interesting a paper, and commend to our readers a more full study of it when published in the "Proceedings" of the United Service Institution.

—*The Engineer*, March 24, 1899.

BOOK REVIEWS.

History of the Gatling Gun Detachment, Fifth Army Corps, at Santiago. John H. Parker, 1st Lieutenant, 13th Infantry. Kansas City, Mo.: Hudson-Kimberly Publishing Co. Pp. 274*.

The most prominent characteristics of this work are: the author's excessive egotism and self-laudation, his exaggeration of the work done by the Gatlings at Santiago, his evident desire to depreciate the work of all the other arms, particularly that of the field artillery, and the unreliability of his statements whenever the employment or effect of the field artillery is in question, or whenever he deems it necessary to make more telling the work of the Gatlings.

That Lieutenant Parker did excellent work with his Gatlings no one doubts, indeed, had he been satisfied with the praises of his superiors, and based his statements in regard to the other arms on the facts in the case, and not on his prejudices, his book would have been well-nigh a classic on the subject, for he had a rare opportunity to test this comparatively new arm on the battlefield (for the first time handled successfully as opposed to field and heavy artillery), and he took full advantage of the opportunity.

Let us consider, in proper order, the points above referred to as characterizing this work.

And first, let us see if our statement in regard to the author's egotism is justifiable. The opening sentence of Chapter I reads:

“The history of the Gatling Gun Detachment, Fifth Army Corps, is to a certain extent the history of the Santiago campaign.”

This is certainly not a *modest* beginning. Again, after stating the views of the different branches of the service as to the probable future value of machine guns in battle, he proceeds thus:

“This view must have been that of our War Department, for it did not even acknowledge the receipt of drawings and specifications for a machine gun carriage, offered freely to the Government as a gift by the inventor six months before the war, together with the first correct tactical outline of the proper use of machine guns ever filed in any War Office in the world. This invention was designed to facilitate the use of the machine gun by making its advance with the skirmish line possible on the offensive, and was recommended by the whole staff of the Infantry and Cavalry School as a meritorious device, worthy of trial. The discussion filed with the invention pointed out, for the first time, the correct tactical employment of the weapon, and staked the military reputation and ability of the author and inventor on the correctness of his views.”

On first reading this, we supposed the invention was the work of some one of considerable experience in the field, or of acknowledged ability, who had a right to expect immediate action by the War Department; but on reading appendix III we discovered that the author himself was the inventor, and then we re-read the above extract. If the reader will kindly do the same, I think we need make no further comment.

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* This book was *sent* to us for review by the publishers. Our review may appear to some of our readers a little severe, but we have attempted to let the author speak for himself, merely adding such words as seemed necessary to connect the quotations.

That we have no personal prejudice against the author is shown by our very complimentary review of his other work in the *Journal*, January-February number, 1899.

Without multiplying quotations on this point, we desire to add one more that speaks so entirely and completely for itself, that we present it without remark:

"The infantry and cavalry had been pounding away for two hours on these positions: in eight and one-half minutes after the Gatlings opened the works were ours."

The quotations above given illustrate not only the egotism of the author, but also the second point in our characterization, namely, his exaggeration of the work done by the Gatlings. But a few further illustrations of the latter tendency are here added.

The following statement seems to us a little premature, to say the least:

"It is also hoped to place before the intelligent American public some correct ideas of the new arm which was tried *thoroughly* at Santiago for the first time in the history of the world." (The italics are ours).

Again, in the same strain:

"The service rendered by this battery has forever set at rest the proper tactical use of the machine gun arm, both on the offensive and defensive. These things are now beyond the realm of theory. They are a demonstrated problem. The solution is universally acknowledged to be correct."

It would appear from his statements that all previous uses of the machine gun during the past thirty years have been mere *theory*, and that Lieutenant Parker's use of them is the first example of any really *practical* use! Moreover, we doubt very much if any student of tactics was very much surprised at the excellent service rendered by the Gatlings, nor has its use at Santiago taught us any *new* lessons of tactics so far as we can discover. General Shafter states in his report:

"In this action on this part of the field most efficient service was rendered by Lieutenant John H. Parker, 13th Infantry, and the Gatling Gun Detachment under his command."

And that is about all there was to it.

The author makes a great point of his work having demonstrated a number of points in the use of machine guns in the advanced positions of the firing line, but this was so well established by previous experience and study that if he will turn to Shaw's *Elements of Modern Tactics*, 8th edition, he will find in the order of march of an advanced guard of a mixed division, 2 machine guns placed in the *support* of the advanced guard, that is, ahead of the main body of the advanced guard.

Again, in Wagner's *Service of Security and Information*, 4th edition, he will find the same thing in the plate on pages 49-50.

So that, evidently, the authorities he seems to despise (See pp. 10, 11 and 12) so much, expected him to use his guns exactly as he did use them, *under the circumstances*. Had he been opposed by an efficient field artillery, such as that which the Germans brought to bear on the French machine guns in 1870, the test would have been much more *thorough*, and the military world would more readily accept his exaggerated ideas of the value of machine guns, had he then been as successful as he was in this campaign.

Now, with regard to the third point, his evident desire to depreciate the work of the field artillery (and in a less degree that of the cavalry and infantry), we would like to call attention to one or two statements, to illustrate his feeling:

"The artillery of the world, which poses in every country as an *élite* body of scientific fighters, and is often found on the battle-field to be an aggregation of abstruse theorists." What battle-fields does he refer to? Surely not those of the Civil War, for our best cavalry officers had nothing but praise for our light artillery, and General Merritt has stated in our hearing that the light batteries could and did go wherever the cavalry went. Surely not that of Santiago, for, however inadequate the work of the field artillery may have been there, no one who knows them would call Capron, Grimes, Parkhurst or Best *scientific fighters* in the disparaging sense of the author, or consider them to be merely *abstruse theorists*. Surely not at St. Privat, where the conduct of the battery commanders on both sides won mutual praise. Indeed, in all our voluminous reading we cannot recall *any* battle-field of recent times, on which the artillery was "an aggregation of abstruse theorists." The proper object of all *theory* is to make *practice* easier, and even the author indulges in theory, for on page 270 he says: "I would now, based on experience, modify my theory of organization." So that, evidently, he too indulged in theory before he had had full experience, like every other thinking mind.

Similar remarks are made about the cavalry and infantry (whose work at Santiago *did* command the respect of the world, and made us all proud of them), and even the medical corps does not escape. Speaking of the latter, he says:

"These gentlemen pose as the most learned, expert, scientific, highly trained body of medical men in the world." Now, as a matter of fact, our personal experience of nearly thirty years in the army, has found these men, as a rule, exceedingly modest, and not inclined to *pose* at all. We recall a few that we knew best and had learned to love: McElderry, Richard, Alexander (retired), Smith (retired), Page (retired), Heizmann, Perley and Bushnell, and could name a score of others of equally mild and modest demeanor. We do not mean to say that we deny the author's statements in regard to mismanagement at the front, indeed, there is little doubt that many failed in doing their full duty, and the author's criticisms, thus limited, may be (no doubt, are) founded on fact, but, admitting this, it is hardly fair to condemn the entire medical corps in one sweeping statement.

For further information regarding the author's evident desire to depreciate the work of the field artillery, as well as the unreliability of his statements in regard to the employment and effect of the field artillery, we refer the reader to the report of the Major-General Commanding the Army, 1898.

Before concluding this review, we desire to call attention to our review (*Journal U. S. Artillery*, January-February, 1899) of the author's other work on this same subject of Machine Guns. In that work he quotes the action of the Maxim guns at Omdurman as substantiating his arguments in favor of machine guns; now, as a matter of fact the Maxim guns generally spoken of in this battle were really rapid-fire *field* guns (or more properly *mountain* guns), for their caliber was nearly 3 inches (2.95), and they fired a projectle weighing 12½ pounds. (See *Revue d' Artillerie*, February, 1899, and *Proceedings Royal Artillery Institution*, February, 1899). So that any argument based on their action, is in reality an argument in favor of field artillery. The machine guns proper were not entirely satisfactory. But more than that, contrary to the impression that Lieutenant Parker endeavors to create, the English lay particular stress on the value of their *large* caliber guns, namely their 5-inch siege howitzers, as having done the work that was most remarkable in this campaign.

To return to the present work of Lieutenant Parker: we have been thus careful to analyse this work on the Gatlings, because of the danger of drawing wrong conclusions in regard to the actual degree to which the Gatlings were tested in this campaign. The truth seems to be that the Gatlings were handled remarkably well, and Lieutenant Parker cannot be too highly praised for his perseverance and energy in organizing the detachment, and for his very efficient service of them, but, the infantry and (dismounted) cavalry of the little regular army, in spite of inadequate preparation by field artillery, won this campaign, and they would have won it if there had been no Gatlings. Better preparation by the field artillery, would no doubt have diminished the losses greatly, as did, no doubt, the presence of the Gatlings, but, as it was, the artillery fire helped *some*, and the Gatlings did not do it *all*.

The publishers have done their part well, and produced a very attractive little volume, well printed, tastefully bound and suitably illustrated.

J. P. W.

Kriegsgeschichtliche Beispiele aus dem deutsch-französischen Kriege von 1870-71, von Kunz, Major a D. No. 8 and 9. Berlin: E. S. Mittler and Sohn. Pp. 257, 2 maps.

The present number of this most interesting and valuable work treats of the *attack and defense of woods*, as illustrated by the battle of the 16th of August, 1870, on the German right, and by the fight of the 5th infantry division.

The author's first intention was to treat only of the combat for the forest of St. Arnould, but he soon found that the combats in the adjacent woods of Vionville and the Bois des Ognons were so intimately connected with the combats around St. Arnould that their description was necessarry to a correct understanding.

But, even this extension of the original plan was not sufficient, and the author found it necessary to include as well the combats for the heights in front of the woods and for the ravines between them. In this way the pamphlet grew to its present size.

The author consulted all the German and French authorities, preserved in the German military archives, and visited the battle-field on three different occasions, spending ten days there on the last occasion, and going over every part of it on foot.

The main part of the work is in reality an accurate description of the field and the events transpiring from the advance of the III Prussian army corps, on the morning of the 16th of August, 1870, to the last struggle in the Bois des Ognons, ending at 10 p. m. on the same day. To this is appended an excellent time table of the events of the day, a separate chapter on the work of the French artillery, and one on the tactical deductions from this day's battles.

The whole is intended more particularly to illustrate the attack and defense of woods, and no better example could be found. The usual accompaniments of fighting in dense woods were found here, namely, the complete disorganization of the units in the woods, the intermingling of units of different organizations, and the great danger of firing on one's own men; and the fighting illustrated the pressing necessity of reforming at every favorable opportunity.

The most prominent characteristic in the employment of the French artillery was the evident desire to save the guns and the great fear of losing them, which prevented the artillery from being massed properly and utilized to the best advantage.

Bazaine's great tactical error was in using his forces purely defensively, and not pushing his advantages in the the early stages of the battle, when he had an overwhelming superiority.

The volume concludes with a series of tactical problems, and a list of the sources for their solution, which constitute an excellent study for military students of tactics.

The typography and paper leave nothing to be desired, and the maps, both contoured, are clear and adequate. One of the maps contains sections of the ground to scale, which give an excellent idea of the slopes.

We know of no better work than this series by means of which to study tactics on *historic* battle-fields, and the method of treatment of the subject is a model for future tacticians.

J. P. W.

Revista Militar, published under the direction of the General Staff of the Army, Rio de Janerio, Brazil.

A new journal of the above title has just made its appearance and promises to have a successful career.

The contents of the first number (March, 1899,) are:

Revista Militar,—editorial note.

Unity of command in the land and sea forces.

Cryptography. The Geographical service of Brazil.

Instructions for repulsing attempts at landing in Cuba. Translated from *Journal U. S. Artillery.*

The manufacture of smokeless powder in the United States. Translated from *Lectures on Explosives*, Lieut. W. Walke.

The *Revista* is published in an attractive form, with about fifty printed pages to the number, and has our best wishes for success.

J. P. W.

Die Umschau.—A weekly publication on the progress and changes in the domains of science, literature and art, Frankfort a M., Germany, 10 M. per year.

The contents of one of the late numbers (May 6, 1899,) of this weekly (now in its third year) indicate that it is keeping up to the standard it originally set for itself, viz:

Extracts from the early life of Sophus Lie, the great geometrician.

The mosquito question (conveying of germs of infectious diseases).

On fermentation and decay.

Chemistry.

War material (smokeless powders and rapid-fire guns.)

Naval matters (torpedo tubes, etc.)

Kleines Militär-Wörterbuch. W. Stavenhagen. II Theil: Deutsch-Französisch, Berlin: R. Eisenschmidt. 1898. Pp. 764. $1.50.

This compact and useful little German-French military dictionary is the counterpart of the French-German volume reviewed last year in the *Journal U. S. Artillery.*

The rapid growth of military literature of late years has necessitated special dictionaries, and this volume will be found useful in clearing up many doubtful points in military works. It is impossible to keep pace with this branch of literature, and every dictionary of this kind can only hope to add its quota to the words found in the common dictionaries, and thus make easier the labors of the reader of such technical works.

Besides the dictionary proper, there is an appendix containing the French equivalents of German military, telegraphic, and topographic abbreviations, the metric system, money, military rank, the strength and organization of the German army and navy, and a brief but excellent bibliography of German military literature.

J. P. W.

BOOK NOTICES.

[These books will be fully *reviewed* as space becomes available.]

Alloys of iron and nickel. Robert Abbott Hadfield, M. Inst. C. E. Published by the Institution of Civil Engineers, London: 1899.

Die Bein und Hufleiden der Pferde. Oberst Spohr. Leipzig; Arwed Strauch. Pamphlet, 2 M., bound, 3 M.

The Naval Annual, 1899. T. A. Brassey. Portsmouth: J. Griffin and Co., 2. The Hard.

Der Krieg um Cuba im sommer 1898. Kontre-Admiral M. Plüddemann. Berlin: E. S. Mittler und Sohn. M. 5.50.

Kriegsgeschichtliche Beispiele aus dem deutsch-französischen Kriege von 1870-71. Major Kunz. 10. Heft. Der Kampf um St. Privat la montagne. Berlin: E. S. Mittler and Sohn.

INDEX TO CURRENT ARTILLERY LITERATURE.

PERIODICALS CITED.

Abbreviations employed in index are added here in brackets.

All the periodicals are preserved in the Artillery School Library, Fort Monroe, Virginia.

ENGLAND.

Aldershot Military Society. *Occasional.*
Aldershot. Copies 6*d each.*

Arms and Explosives. [*Arms and Ex.*] *Monthly.*
Effingham House, Arundel Street, Strand, London, W. C. Per year 7*s.*

Army and Navy Gazette. [*A. and N. Gaz.*] *Weekly.*
3 *York Street, Covent Garden, London. Per year* £1 12*s* 6*d.*

Canadian Military Gazette. [*Can. Gaz.*] *Fortnightly.*
Box 2179 *Montreal, Canada. Per year* $2.00.

The Engineer. [*Eng.*] *Weekly.*
33 *Norfolk Street, Strand, London. Per year* £2 6*d.*

Engineering. [*Eng'ing.*] *Weekly.*
35-36 *Bedford Street, Strand, London, W. C. Per year* £2 6*d.*

Journal of the Royal United Service Institution. [*Jour. R. U.S.I.*] *Monthly.*
22 *Charing Cross, Whitehall, London, S. W. Per year* 24 *s.*

Journal of the United Service Institution of India. [*Jour. U. S. I. India*] *Quarterly.*
Simla, India. Per year $2.50.

Photographic Journal. [*Photo. Jour.*] *Monthly.*
12 *Hanover Square, London.*

Proceedings of the Institution of Civil Engineers. [*Proceedings I. C. E.*]
25 *Great George Street, Westminister, London.*

Proceedings of the Institution of Mechanical Engineers.
[*Proceedings I. M. E.*] 19 *Victoria Street, Westminister, London.*

Proceedings of the Royal Artillery Institution. [*Proceedings R. A. I.*] *Monthly.*
Woolwich, England.

Professional Papers of the Corps of Royal Engineers.
[*Prof. Papers Corps Royal Eng'rs.*]
Chatham, England.

Review of Reviews. [*Rev. of Rev. Austral.*] *Monthly.*
169 *Queen Street, Melbourne, Australia. Per year* 11 s. 6 d.

Transactions of the Canadian Institute. [*Trans. Canadian Inst.*]
58 *Richmond Street, Toronto, Canada.*

Transactions of the Canadian Society of Civil Engineers.
[*Trans. Canadian Soc. C. E.*]
Montreal, Canada.

Transactions of the East of Scotland Tactical Society.
[*Trans. E. of S. Tactical Soc.*]
51 *Hanover Street, Edinburgh, Scotland.*

Transactions of the Institute of Naval Architects.
[*Trans. Inst. Naval Architects.*]
5 *Adelphi Terrace, London, W.C.*

United Service Gazette. [*U. S. Gaz.*] *Weekly.*
10, *Wine Office Court, Fleet Street, London, E. C. Per year* £1 10 *s* 6 *d.*

United Service Magazine. [*United Serv. Mag.*] *Monthly.*
13 *Charing Cross, S. W. London. Per year* 27 *shillings.*

FRANCE.

Le Génie Civil. [*Génie C.*] *Weekly.*
6 *Rue de la Chaussée d'Antin, Paris. Per year* 45 *Fr.*

La Marine Française. [*Marine F.*] *Semi-monthly.*
26 *Rue de Grammont, Paris. Per year* 30 *Fr.*

Mémoires et Compte Rendu des Travaux de la Société des Ingénieurs Civils.
[*Ingénieurs Civils.*] *Monthly.*
10 *Cité Rougemont, Paris. Per year* 36 *Fr.*

Mémorial des Poudres et Salpêtres. [*M. Poudres et S.*] *Quarterly.*
Quai des Grands-Augustins, 55, *Paris. Per year* 12 *Fr.*

Le Monde Militaire. [*Monde.*] *Fortnightly.*
76 *Rue de Seine, Paris. Per year* 6 *Fr.*

Revue d'Artillerie. [*R. Artillerie.*] *Monthly.*
5 *Rue des Beaux-Arts, Paris. Per year* 22 *Fr.*

Revue de Cavalerie. [*R. Cav.*] *Monthly.*
Berger Levrault et Cie, Rue des Beaux-Arts 5, *Paris. Per year* 33 *Fr.*

Revue du Cercle Militaire. [*Cercle.*] *Weekly.*
37 *Rue de Bellechasse, Paris. Per year* 27 *Fr.*

Revue du Génie Militaire. [*Génie M.*] *Monthly.*
8 *Rue Saint-Dominique, Paris. Per year* 27 *Fr.*

Revue d'Infanterie. [*R. Inf.*] *Monthly.*
11 *Place Saint André-des-Arts, Paris. Per year* 25 *Fr.*

Revue Maritime. [*R. Maritime.*] *Monthly.*
L. Baudoin, Rue et Passage Dauphine 30, *Paris. Per year* 56 *Fr.*

Revue Militaire de l'Etranger. [*Etranger.*] *Monthly.*
L. Baudoin, Rue et Passage Dauphine 30, *Paris. Per year* 15 *Fr.*

Revue Militaire Universelle. [*R. Univ.*] *Monthly.*
11 *Place Saint André-des-Arts, Paris. Per year* 25 *Fr.*

Le Yacht—Journal de la Marine. [*Yacht.*] *Weekly.*
55 *Rue de Chateaudun, Paris. Per year* 30 *Fr.*

GERMANY.

Allgemeine Militaer-Zeitung. [*A. M.-Zeitung.*] *Semi-weekly.*
Darmstadt. Per year 24 *M.*

Archiv fuer die Artillerie-und Ingenieur Offiziere. [*Archiv.*] *Monthly.*
Koch Strasse, 68-78, *Berlin, S. W.* 12. *Per year* 12 *M.*

Beiheft zum Militaer-Wochenblatt. [*Beiheft.*]
Koch Strasse, 68, *S. W.*, *Berlin.*

Deutsche Heeres-Zeitung. [*Heeres-Zeit.*] *Semi-weekly.*
Wilhelmstrasse 15, *Berlin. Per year* $6.00.

Internationale Revue. [*Int. Revue.*] *Monthly.*
Blasewitzer Strasse 15, *Dresden. Per quarter* 6 *M.*

Jahrbuecher fuer die deutsche Armee und Marine. [*Jahrbuecher.*] *Monthly.*
Mohren Strasse, 19, *Berlin*, *W.* 8. *Per year* 32 *M.*

Kriegstechnische Zeitschrift. [*Kriegsteck.*] *Ten numbers a year.*
Koch Strasse, 68-71, *Berlin. Per year* 10 *M.*

Kriegswaffen. [*Kriegswaffen.*] *Monthly.*
Rathenow, *Germany. Per year* $4.50.

Marine Rundschau. [*Mar. Rundschau.*] *Monthly.*
Koch Strasse, 68-70, *Berlin. Per year* 3 *M.*

Militaer-Wochenblatt. [*Wochenblatt.*] *Semi-weekly.*
Koch Strasse, 68, *Berlin*, *S. W.* 12. *Per Year* 20 *M.*

Militärische Rundschau. [*Mil. Rundschau.*] *Occasional.*
Zuckschwerdt & Co., *Leipzig. Per quarter* 4.75 *M.*

Stahl und Eisen. [*Stahl u. Eisen.*] *Fortnightly.*
Schadenplatz 14, *Düsseldorf. Per year* $5.00.

Umschau, Die. [*Umschau.*] *Weekly.*
Frankfort a. M. Per year 10 *M.*

AUSTRIA.

Mittheilungen ueber Gegenstaende des Artillerie und Genie-Wesens.
[*Mitth. Art. u. G.*] *Monthly.*
Wien, *VI*, *Getreidemarkt* 9. *Per year* 1 *Fl.* 50 *Kr.*

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Calle Colonia, No. 379 *A. Montevideo, Uraguay.*

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3, *West* 29*th Street, New York City.* *Per year* $3.00.

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421 *Market Street, San Francisco, Cal.*

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THE MONITOR, THE BATTLESHIP, THE CRUISER AND THE DESTROYER.

BY G. W. DICKIE.

Reprinted from *The Engineering Magazine*, April, 1899.

The subject of this article is not of my own choosing. When the editor steered this fleet into my harbor he asked me to look at the vessels and give my opinion of their usefulness, as types of fighting ships. He asked me to consider whether the Spanish-American war suggested any modifications of these types or the further consideration of European practice and late designs. He also asked me to compare the types as to functions, sphere of action and relative efficiency, and to examine the matter of their apportionment, as to number and service, in a naval establishment.

In attempting to comply with this request, I must, at the outset, acknowledge that, although I have had a little experience in the building of each type of warship reprsented in the title of this article, I am by no means qualified to write with authority on the qualities most to be desired in these various types of war-ships, especially within the limits here set. I must therefore confine myself to the expression of my own opinion in regard to the designs at present accepted for these various types of fighting vessels; and this I propose doing from the engineer's and ship-shipbuilder's point of view. These types I will consider in the order given.

The Monitor—This type of war vessel is not the result of development from simpler forms that suggested the direction of improvements; it is an invention that embodied at first all the principles that characterize the type to-day; it was born of necessity, and has held a place in the United States navy since its advent, because of the good work done by the first vessels of the class.

The United States navy, however, is the only one that has a class of vessels that can be called monitors. While this type was the direct cause of many modifications in the hulls and batteries of the battleships in the navies of Europe, in no case was it adopted as a type. The very low freeboard and light draught of the monitor did not appeal to the British and French naval constructors as qualities worth the sacrificing of so many desirable qualities; so they took from the monitor some of its peculiar features, and worked them into their own designs in such a way as to completely hide the type. It is only when we take these designs apart that we find the monitor embodied in the very center of their structure.

H. M. S. DREADNOUGHT.

10.820 tons, 6,500 i. h. p., 13.5 knots; 320 x 63.10 x 26.9 feet; 4 12.5-inch guns, in pairs, in turrets; 6 6-pdr. and 12 3-pdr. quick fire; 7 machine guns; 2 torpedo tubes to be fitted.

(By courtesy "*The Engineering Magazine*.)

Take the British war-ship *Dreadnought*, and remove the upper deck and sides, forward and aft. to the berth deck, and you have practically the double-turreted monitor left, with the superstructure armored, and the draught of water greater than the monitor's.

The French ships *Tréhouart* and *Bouvines* may be regarded as modified monitors, but these ships have had a superstructure added forward, to improve their sea-going qualities, since they went into commission.

The monitor, therefore, as a distinctive type, not only originated in America, but is found nowhere else. In the country of its origin it holds a high place in popular estimation, and could not be abandoned by American naval authorities without reasons strong enough to convince Congress.

Amongst American naval officers, and especially among those who have commanded or served on monitors, this type is considered a very important factor in the navy. Some of these officers claim for it that it has a more extended sphere of usefulness than has been assigned it by its designers. There is no doubt that monitors have frequently performed duties for which they were not intended, and have succeeded to a certain extent in performing these duties satisfactorily. For instance, there were several monitors in the sea-going fleet under Admiral Sampson, and the *Monterey* and *Monadnock* were sent from San Francisco to Manila; yet the monitor type would never be designed and built for such service. Admiral Sampson did not consider his fleet very much improved by the presence of the monitors, and the *Monterey* and *Monadnock* reached Admiral Dewey only by being towed most of the way.

U. S. MONITOR MONTEREY.

4,138 tons, 5,072 h. p., 14.4 knots; 256 x 59 x 14.9 feet; 2 12-inch guns in fore barbette, 2 10-inch in aft barbette; 6 6-pdr. quick fire; 2 Gatlings.

(By courtesy "*The Engineering Magazine*".)

The monitor is essentially a harbor-defence vessel, and its great advantage lies in the fact that so little of the vessel is out of water, making armor protection possible and effective, with little weight, and enabling a heavy battery to be carried on a comparatively small displacement, which means small dimensions and light draught. All these qualities are very good, and if they were accompanied by others necessary in a sea-going vessel, the monitor would have a wider range of action than can now be accorded it.

The small amount of exposed hull means a low freeboard. This renders speed practically unattainable. The *Monterey*, with 4,000 tons' displacement, has, say, 30 inches' freeboard ; draught of water, 14 feet. In smooth water, at 10½ knots, the wave comes over the bow. At full power, 5,200 horse, the depth of water above the stem is about 7 feet, and at the forward barbette the water is 18 inches deep on deck. Speed therefore is out of the question. The small dimensions and shallow draught, coupled with the small range possible between normal and load water lines, renders large coal-capacity impossible. Hence the radius of action is limited to a small circle.

The main battery, being carried so near the water-line, can be used only in practically smooth water. In short, the monitor is an ideal harbor-defence vessel, and should not be expected to perform sea-service, for which her design is entirely unsuited.

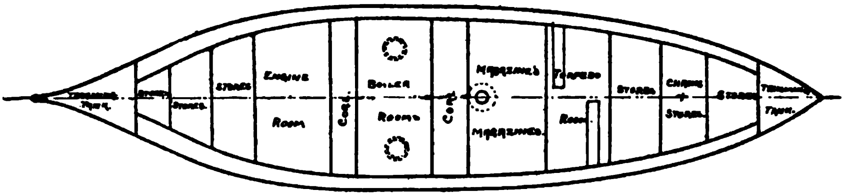
Since the monitor was invented, the enemy it must meet has become a far more powerful fighting machine than that against which it was orginally pitted so effectively. The monitor cannot get so close to the enemey now as before ; owing to its slow speed, it must be more on the defensive, and should be fitted accordingly. Besides its big guns, of which it should always have four in two turrets,—all alike, so as to have all the ammunition available,—it should have a large secondary battery of quick-firing guns for defence against torpedo attack, to which a monitor is peculiarly subject.

The four monitors of the *Arkansas* class, just ordered by the United States government, do not meet expectations as to the main battery, although provided with an excellent secondary battery.

In a fight with a faster ship of equal maneuvering power, the single turrett could be kept masked by the superstructure.

In my opinion, if a single-turreted monitor is built, it should have an all-around train for the turret, all living quarters being under the main deck. In this case the secondary battery could be installed on a platform above the turret, which should be made large enough to mount four 8-inch quick-firing guns, with a small independent train. The platform would have hammock berthing all round, with, say, two 4-inch guns and six 6-pounders.

At this point the question naturally occurs to a designer: Why have a revolving turret at all, with its intricate and delicate mechanism, that admits of fighting from only one side, when a circular redoubt, of a diameter nearly equal to the beam of the vessel, would enable at least two guns to be directed on one object, and the superstructure would be a fixed platform, enabling each gun to be worked independently.



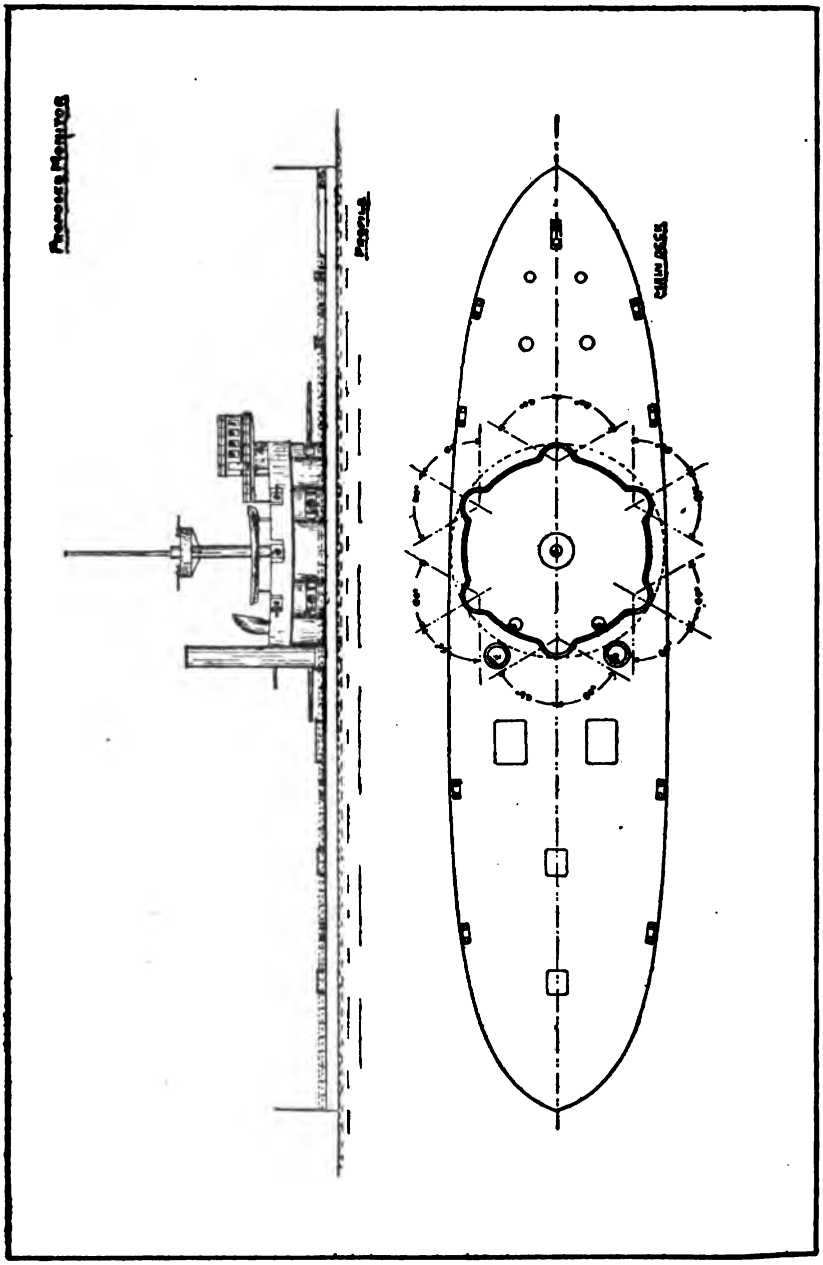
PROPOSED MONITOR. HOLD PLAN.

On these lines I have worked out a scheme that enables a battery of six 8-inch quick-firing guns to be effectively mounted, the barbette being 50 feet in diameter. and the upper platform 58 feet, which gives room for ten 6-pounders. The magazines would be located forward of the coal bunkers, the ammunition being served by endless chains worked by electric motors. The arrangement would be somewhat similar to that shown in the sketch plans. In such a vessel the danger of damage to the turret-turning gear is eliminated, and each gun is independent of its neighbor.

A vessel having the revolving turret as its distinctive feature, while coming under the class or type to which the monitor belongs, would hardly be accepted in the United States as a monitor. Yet, I think, if the type is to be retained it will undergo some such modification.

As the natural weapon for attack on the monitor is the torpedo, I have thought it strange that the monitor has not been fitted with means of defence against this attack, or with any means of returning it. There is no difficulty in fitting a monitor with submerged tubes, and it appears to me that, in its special function of harbor and coast defense, it would have more and better opportunities to use them than battle-ships or cruisers would have. I therefore show two submerged torpedo tubes fitted directly on the inner bottom forward of the magazines. The center lines of these tubes would be about nine feet below the surface of the water; although not quite as deep as such tubes are in battle-ships, they are certainly within the limits of effective working, and would be a great addition to the monitor's offensive power.

I have already devoted more space to the monitor than its comparative importance warrants. Yet, if it is possible to preserve the good qualities that undoubtedly belong to the monitor,



PROPOSED MONITOR. Profile and Main-Deck Plan. (By courtesy *Engineering Magazine.*)

and to add other qualities that will enable it to act as a coast defence vessel, where voyages of considerable duration must be made at sea,—sometimes a necessity, especially on the western coast of the United States,—such a type of vessel will be able to do work that now requires a battleship or armored cruiser.

At the same time, it must be admitted that the battle-ship or armored cruiser can accomplish much that the monitor cannot, and this fact will limit the application of the monitor type, no matter how modified, to harbor and coast defense; its principal limitations being the extremely low freeboard which limits the speed and the small coal capacity.

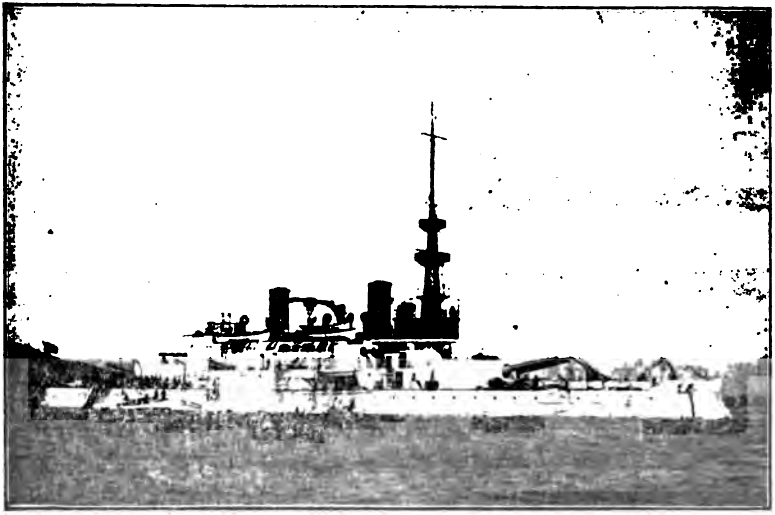
Battleships—This type of vessel in its various modifications, notwithstanding the many predictions that new instruments of attack would render it worse than useless, is still the backbone of all the great navies of the world.

The most noticeable thing at the present time is the narrowing of the difference between the battleship and the armored cruiser. The latter, in some cases, now equals the largest battleship in displacement, while the latest battleships have very nearly the speed of the fastest armored cruisers. The marked increase lately effected in the resistance of armor has enabled the battleship designer to decrease the thickness of armor, and spread it over a much larger area. Consequently, the battleship has increased in length and in firmness, and with these qualities speeds hitherto thought impossible are now obtained with certainty on the new ships of this class. This advance has been so marked that there appears to be little or no room left for a distinct type of armored cruiser readily distinguishable from the battleship.

At present the United States have four first-class battleships in commission, and eight in course of construction. The first three, the *Indiana*, *Massachusetts* and *Oregon*, may be termed low-freeboard battleships, as there is no structure above the main deck at the ends, the superstructure extending only between the main turrets.

These ships carry a very heavy main battery, consisting of four 13-inch, eight 8-inch, and four 6-inch guns. Their low freeboard has been commented on as unfitting them for ocean service; yet the *Oregon* has proved that these ships are not deficient in sea-going qualities. Though they are not as fast as the latest types of this class, the *Oregon*, built as a 15-knot ship, can respond at any time to an order for 16 knots.

The main turrets of the *Oregon* are operated by hydraulic power, while in her two sister ships the main turrets are operated



U. S. S. OREGON.

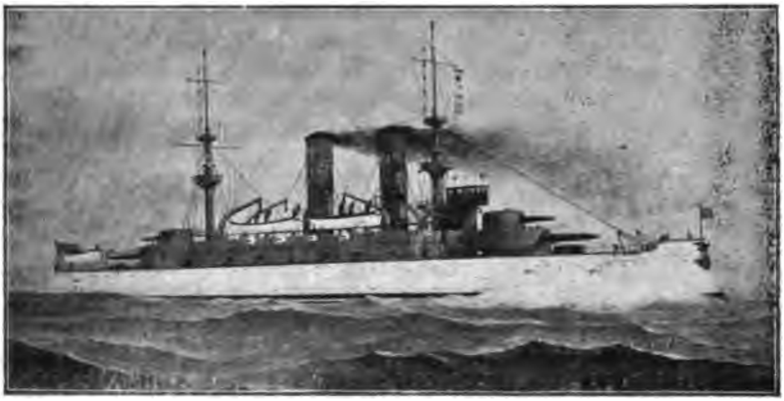
10,231 tons, 9,500 h. p., 17.5 knots; 348 x 69.3 x 24 feet; 4 13-inch guns, in pairs, in turrets; 8 8-inch, in pairs, in turrets, 2 on each beam; 4 6-inch quick fire in sponsoons; 20 6-pdr. and 6 1-pdr. quick fire; 4 Gatlings; 7 torpedo tubes.

(By courtesv "*The Engineering Magazine*".)

by steam. I have not been able to obtain any correct data indicating which power is most to be depended upon in action. The battleships have not yet been tested in an equal contest with ships of the same class, and the Spanish-American war, beyond strengthening the opinion that the first and best thing for a great navy is battleships of the highest class, added little to our knowledge of their merits and demerits.

The *Iowa* followed the first three, and in her the effect of criticism is noticeable. The superstructure extends to the bow, and 12-inch guns replace the 13-inch, the forward turret being above the superstructure deck. This was expected to be, and is regarded as, a sea-going battleship, and for comfort in the men's quarters it is better than the three first vessels.

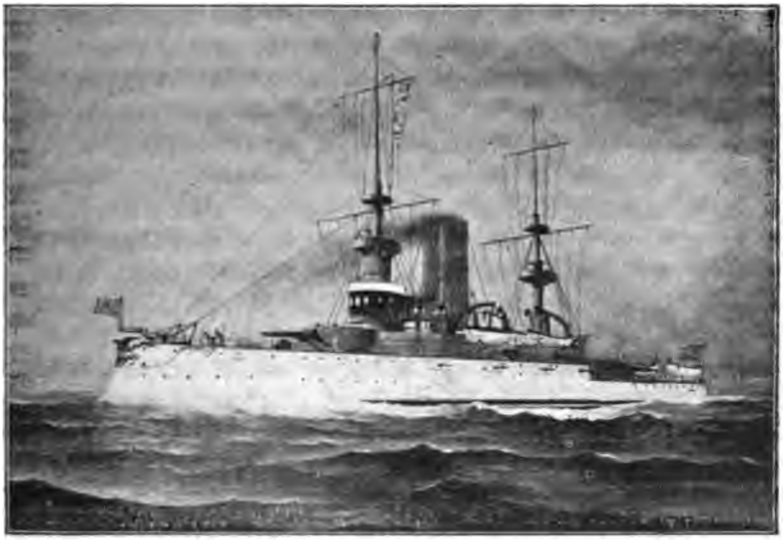
The next two, the *Kearsarge* and *Kentucky*, differ from the others in having both main turrets on the main deck; but that deck is higher, relative to the water line, than the decks of vessels of the *Oregon* class. The main belt is carried to the stem; 13-inch guns are again found in the turrets; four 8-nch guns instead of eight, and the 8-inch turrets are built on the roof of the 13-inch turrets, and train with them. To train together four guns, all of which are dependent on one piece of intricate machinery, is, I think, a mistake.



U. S. S. KENTUCKY.

11,500 tons, 10,000 h. p. 16 knots. Dimensions practically the same as the Illinois. 4 13-inch and 4 8-inch guns in pairs, in superposed turrets; 14 5-inch quick fire; 20 6-pdr. and 6 1-pdr. quick fire; 4 machine guns; 5 torpedo tubes.
(By courtesy "*The Engineering Magazine*".)

In the next three, now being built, the *Alabama*, *Illinois* and *Wisconsin*, the forward turret has again been raised, the superstructure extending to the bow; the 8-inch guns have been left



U. S. S. ILLINOIS.

11,525 tons, 10,000 h. p., 16 knots; 368 x 72 x 23.6 feet; 4 13-inch guns in pairs, in turrets; 14 6-inch quick fire; 17 6-pdr., 6 1-pdr. quick fire; 4 machine guns; 4 torpedo tubes.

(By courtesy "*The Engineering Magazine*".)

out, and a battery of 6-inch quick-firing guns has been substituted. The belt armor is carried forward to the stem. The contract speed is 16 knots. It is confidently expected, however, that the speed will be about 17 knots, with 1-inch air-pressure in the fire rooms.

The last three battleships for the United States navy, just contracted for, were to have been constructed from the plans of the *Alabama* class, but the desire for greater speed induced the navy department to invite builders to tender for 18 knots instead of 16, as intended. These ships, therefore, will be twenty feet longer than the *Alabama*, and will have a power exceeding the *Alabama's* by about 3,000 horse.

Owing to the light draught of water,—light as compared with that of British battleships, 23½ feet normal,—the new United States battleships will not have so fine lines, and therefore must have greater power to obtain the speed required. The dimensions fixed upon are: 388 feet long; 72 feet beam; draught of water at 12,500 tons displacement, 23 feet 8½ inches. They will be the first of the United States ships to have submerged torpedo tubes. They are to carry one thousand tons of coal on their normal displacement, and have bunker capacity for two thousand tons.

As a result of experience gained during the late war, wood is to be used as little as possible, and, where used, it is to be subjected to the treatment known as the electric fire-proofing process. There is no doubt that the substitution of light corrugated steel for wood in all partitions and bulkheads in living quarters gives to these rooms a prison-like appearance that is anything but comfortable. But the need of a better material for this purpose will in time produce it. Boards made from pulp that is thoroughly fire-proofed and stamped into artistic shape will, no doubt, soon take the place of corrugated-steel plate, and fireproof rooms be as attractive as those of wood.

The most needed improvement on warships at present is simpler mechanism for all purposes that require power. Since I have had to do with the getting out of machinery adapted to the many and varied requirements on these vessels, I have never missed an opportunity to advocate greater simplicity and directness in applying the power to the work to be done. Shipbuilding and naval traditions are the strongest obstacles to be overcome in attempts to improve in the direction of simplicity. The warship is a growth, and, while new methods are invented for certain purposes and adopted, the old methods are still retained, until in some ships we find several ways of doing the same thing, all adding to the general complication.

The firm with which I am connected is just finishing a warship for the Japanese navy. It is lighted by electricity. The generators are in triplicate, to insure against failure, and the wiring is divided into several circuits, so that only a portion of the lights would be extinguished in case of failure in transmission. Yet, after all that care, oil-lamps must be fitted wherever light is required, and, lest there should be no oil in the lamps, three hundred candle-sticks must be furnished.

While this question of simplicity is a general one, and applies to all classes of naval ships, yet I may state here in what way I would simplify battleship operations requiring power.

Owing to the divided responsibility in the construction of warships, the design partakes largely of the methods favored by the various bureaus that control certain parts of the work, and therefore a homogeneous whole cannot be expected.

In the important matter of power-transmission I do not know of a single ship in which one mode of transmission has been adopted throughout the ship. Steam pipes, water pipes and electric wires are still run side by side from end to end of the ship, where one would answer all purposes. While I have been a strong advocate of hydraulic power-transmission on warships, there are so many operations in which electric transmission seems to meet the conditions more directly that I now think we are fast reaching a stage of development in the application of this subtle agent, which will render it the best means by which to operate all mechanism requiring power on board warships. The use of only one means of transmitting power on a given ship would be a great step in the direction of simplicity.

In nature we find that living organisms, when they have no further use for an organ that played an important part in the life of their ancestors, have the means of suppressing, or blotting out, as it were, the useless organ. But shipbuilders carry along a lot of appendages hardly ever used at the present day. The old sailing ship of the line required an efficient system of hand, fire, and bilge pumps, so arranged that men could work at them. Now we have an elaborate system of steam pumps for drainage and fire purposes, and yet the old hand pumps are fitted with their long cranks and many valves and connections to manifolds, although never used except in tests of their condition.

The whole drainage system on these ships has been a growth, and, in consequence, needs to be freed from the many appendages that have outlived their usefulness. I see no reason why a main drain should not be provided in the construction of the hull, by having two vertical keel plates instead of one, the space between being the main drain well, extending from end to end of the ship. All compartments would drain into this well through valves controlled from the deck, and the pumps would draw directly from it.

Another complication is ventilation and heating. These matters, in the United States navy, are under separate bureaus, the ventilation coming under the head of construction, and the heating under that of engineering. The heating system is a source of great trouble. The large amount of piping and the many fittings render it very difficult to prevent leaks. Now, with artificial ventilation as carried out for all living spaces on warships, it would be a very simple thing, to have each ventilating fan or blower deliver through a heater box fitted with the proper amount of steam-pipe surface, thus heating the fresh air to be sent through the living spaces, instead of running the hot steam pipes all over the ship.

Where new methods of operating are adopted, they should always be reliable enough to displace the old methods, instead of being added to them, as usual. I have never seen a telemeter, for instance, applied to operating the valve mechanism of a steering gear, that replaced the appliances already in use for the same purpose.

In the engineering department the same duplication of methods for accomplishing a given purpose prevails. The only thing remaining for which but one method of operating is provided is that of turning the propeller, which has come to be apparently of less importance than the question of how to handle feed-water pumps, filters, heaters and the numerous accessories pertaining to what used to be considered secondary matters.

If the whole auxiliary system were blotted out and a fresh start made with the simple purpose of meeting all requirements as simply and directly as possible, much of the present complication could be avoided. There should be a pumping compartment, with the most economical pumping plant in duplicate for feed-water, its function to be that of taking feed-water from the feed tank, and delivering it into a feed main at a pressure sufficiently above the boiler pressure to make the feed absolutely sure. A loaded valve on this pipe would return the surplus to the feed tank. The attendant would regulate the speed of this pumping engine by the flow from the surplus valve. A bilge and fire pumping engine in duplicate would also be in the same compartment. A set of low-pressure pumps would also be required for water service, sanitary service, and circulation in auxiliary condensers and distillers. Main bearings, guides, etc., that have closed water circulation for keeping the parts cool, should discharge into the sanitary tanks overboard. The present plan of having them open to the bilge involves much pumping.

The great mass of pipes, valves, and manifolds, now fitted always in duplicate, and often in quadruplicate, is often more a source of danger than of safety. They are now made with little margin of strength. A small amount of wear or corrosion puts them out of service, and usually the duplicate is in the same condition as the original. If seventy-five per cent. of the material now put in duplicate pipe systems were put in one substantial arrangement, there would be less liability to derangement, and only one-half the stuff to care for. I am satisfied that one-half the piping and valves could be removed from the engine and boiler compartments of our war-ships, in accordance with a plan that would increase their efficiency, reliability, and safety. It only requires that the traditions of the service be laid aside, and a new start made on common-sense principles.

In the change that is taking place in the type of boiler used on war-ships, the usual conservatism in regard to naval practice has been cast aside; where it was hardly possible with the Scotch boiler for the engineer to obtain space enough to install the boilers as to get the very best result, the water-tube boiler now demands practically the whole ship under the protective deck. The argument in favor of this type of boiler—that it is lighter than the Scotch for a given power (I refer to boilers of the Belleville type)—has been given up for another that may have more foundation in fact,—viz., the possibility of making repairs without opening the decks of the vessels. It has been customary to install Scotch boilers in war-ships without regard to convenience in the matter of repairs. I have seen air shafts built over fire rooms not large enough to permit the passage of a furnace, when an inch or two more would have made the removal of a furnace as easy as on a merchant vessel.

The contention that Scotch boilers would not stand forced draught has been settled by the fact that a large proportion of merchant steamers now use forced draught constantly, making continuous records of more than 20 h. p. per foot of grate, while in war-ships such a record is about the best reached for a trial of a few hours, and it was considered a great success if the boilers were not injured in doing it.

It is not yet time to claim that the water-tube boiler in any of the many form now in use is to be the boiler for war-ships of the future. The question of endurance under unfavorable conditions has yet to be decided, as also the question of fuel economy.

As it stands to-day, the navy department of the United States stands committed to a trial, on a grand scale, of the water-tube boiler on battle-ships. This will have the effect of lengthening the ships, as a form of water-tube boiler suited for sea service cannot be installed in the space that accommodates the Scotch boiler, while more room must be given to evaporators for the production of fresh water, and more again to storage of the water thus produced. Skill that may be acquired in the management of water-tube boilers may reduce the work for evaporators, and thus save fuel used for that purpose.

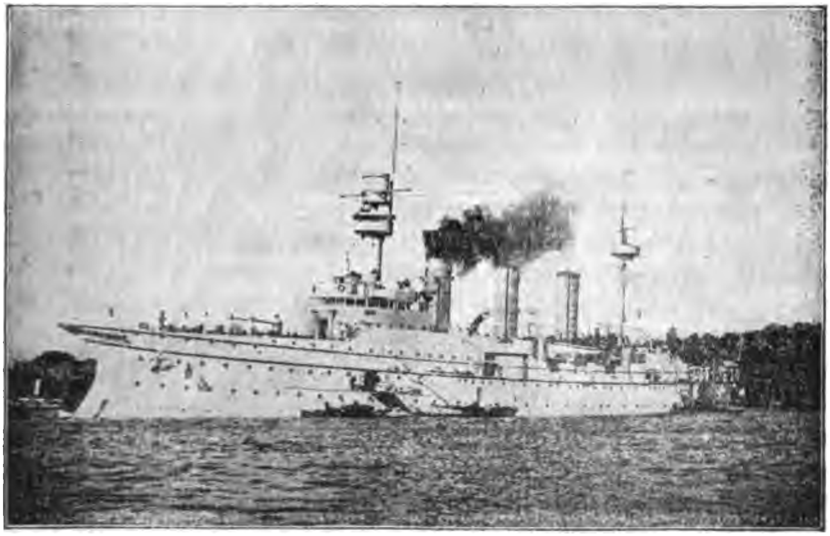
The small amount of water in the boilers to take up and give out heat as the fire temperature varies is the principal cause of difficulty—to be overcome only by the skill and vigilance of those in charge.

That the water-tube boiler has made little progress in the merchant service, where economy in fuel and in operating expenses is more closely watched than in the navy, need not be taken as an argument against its use in the navy, there being other factors than expense that may outweigh all economic considerations.

Having treated, in the preceding paper, the heavier figthing units of the navy, it remains to discuss the lighter types—the cruiser and the destroyer. Both of these—unlike the monitor, which is almost distinctively American—are common to the navies of the world.

THE CRUISER.

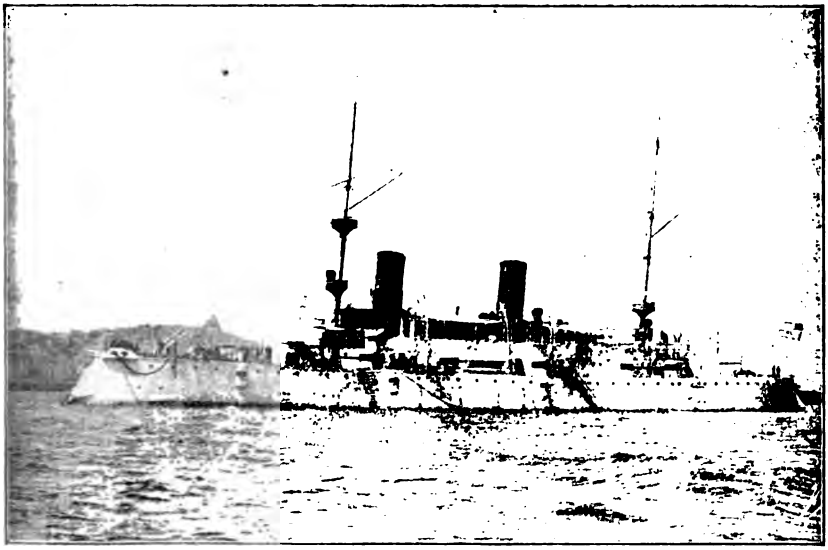
Most navies have two types of cruisers, armored and protected. The armored cruiser in the great navies now equals the largest battle-ships in displacement, and in fighting qualities is not much behind them. At the same time, as already pointed out, the battle-ship proper has lengthened and become fine enough for eighteen or nineteen knots, and these very heavy ships will maintain their speed under conditions that would compel smaller ships to slow down. It does not appear necessary, therefore, to build a class of cruiser that is as expensive as a battle-ship, while not so strong either for offence or defence, and at best only two knots faster. I believe that the armored cruiser and the battleship will in the near future merge into each other, the result being a vessel having the best qualities of both.



GERMAN CRUISER HERTHA, 5,650 TONS, 9,000 I. H. P.

(By courtesy, "*The Engineering Magazine*".)

I think that in action the new high-powered cruisers, fitted with water-tube boilers, will be in danger from the number of smoke



U. S. CRUISER OLYMPIA.—5,800 TONS, 17,363 I. H. P.—DEWEYS FLAG-SHIP.

(By courtesy "*The Engineering Magazine*".)

pipes, usually four, the shooting down of any of which would interfere seriously with the working of guns and the ammunition service.

The protected cruiser seems to be the ideal vessel for cruising purposes. Experience indicates that these should be of two sizes,—say of four thousand and six thousand tons' displacement. Of the latter size the Olympia is the only one in the United States navy. There are, however, a number of the former size, and some that are larger than the Olympia, the latter class including both armored and protected cruisers. I think, however, that the generally-expressed opinion of naval officers is in favor of six thousand tons for the larger class of protected cruiser, and four thousand for the smaller class, both to have a maximum speed of twenty-two knots.

TORPEDO-BOAT DESTROYER.

I have some doubt as to whether this type of vessel has been properly named. It depends upon the meaning attached to the word boat. If the meaning is a torpedo boat intended to destroy other torpedo boats, the name is not so terrible. But, if it means a torpedo boat whose business is destruction in general, then the name accounts for the dread that great war-ships have had of them. The United States had no boats of this class during the late war, and, although the Spanish had some that were considered very good, they evidently lacked the skill or courage to use them, so that nothing has been learned as to value, either for offence or defence, of this type of fighting machine. In a paper read before the Society of Naval Architects and Marine Engineers at the last annual meeting in New York, I endeavored to point out what, in my opinion, are the chief characteristics required in a sea-going torpedo-boat destroyer. That these vessels must be considered as sea-going is admitted, since the place assigned them in a naval expedition is with the attacking force, their duties being to guard against torpedo-boat attacks from shore, and to keep the large ships informed as to the whereabouts and evident intentions of the enemy. They must be able to do this in all kinds of weather, must have considerable fuel endurance, and must have more speed than protected cruisers. Can it be said that the present type of so-called torpedo-boat destroyers meets these requirements? A majority of these destroyers, when in good order, meet the requirements in the matter of speed for short distances in smooth water. But this one quality of speed has been made so paramount to all other qualities that the full speed can be reached only when the conditions are such that the sea-going qualities can be neglected.

If we consider the conditions of service for such a vessel, stationed on the Pacific coast of the United States, we find that, though these conditions do not differ in kind from those that prevail on the Atlantic seaboard, the adverse conditions are far greater. The great distance between harbors on the Pacific coast, and the almost constantly rough water along the coast from Point Conception on the south to Cape Flattery on the north, with only one harbor, render it necessary for any vessel, for practical service outside the harbor of San Francisco or the smooth waters of Puget Sound, to have good sea-going qualities and to be able to remain outside in all conditions of weather.

The qualities necessary for such service are not possessed in any degree by the present torpedo-boat destroyers. While they have made voyages of considerable length at sea, they have done so usually under the care of a larger vessel, and, while doing so, they have needed extra care, both in watching the weather and taking advantage of every shelter that lies in the way. If the destination is reached without mishap, it is something to be proud of as an achievement entirely outside of the service for which the vessel is fitted. During such movements these vessels have to be stripped of all their armament to render them possible.

Now, such a vessel in commission on the Pacific coast cannot

U. S. TORPEDO BOAT DESTROYER ROWAN, 27[illegible] TONS.

(By courtesy "*The Engineering Magazine*".)

go from San Francisco harbor to any other harbor without making an ocean voyage of several hundred miles, during which it probably will encounter rough weather.

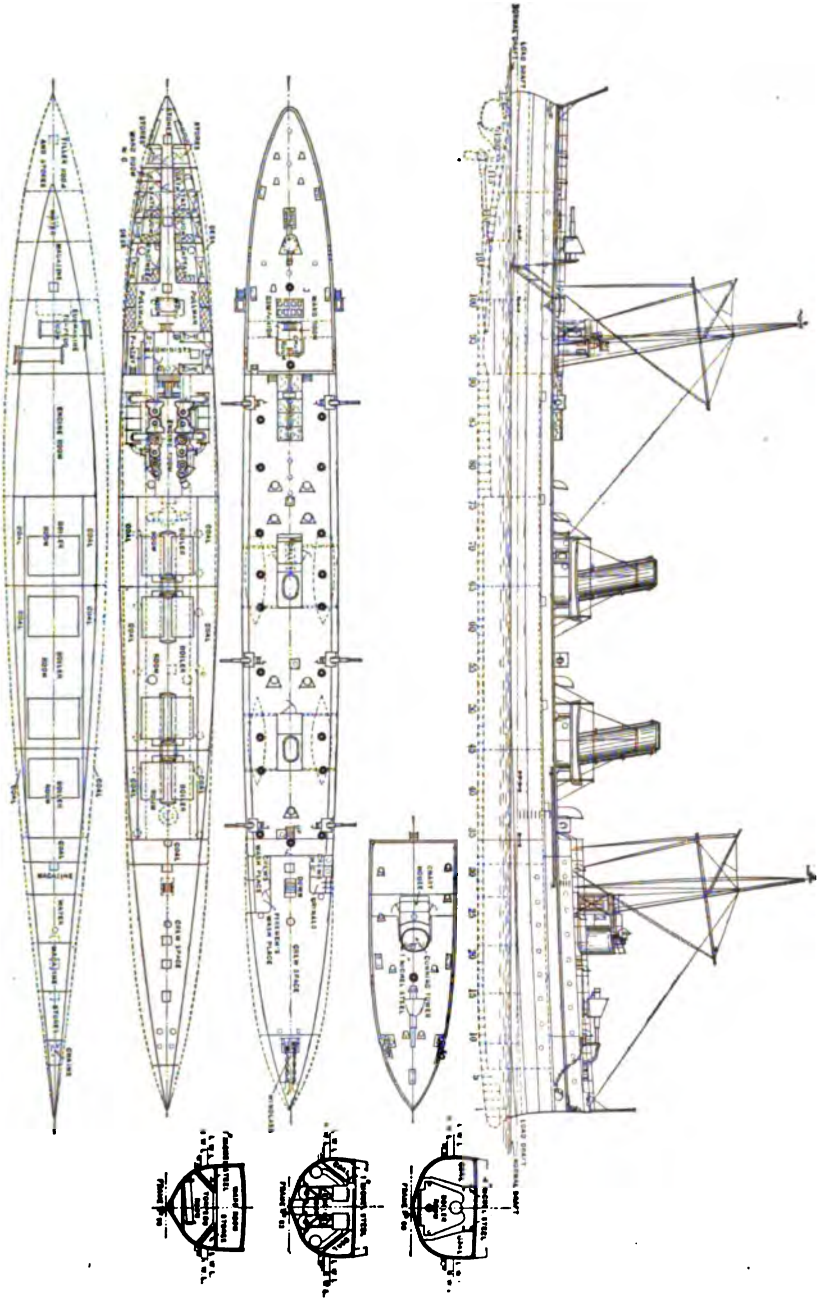
The 420-ton destroyers lately ordered by the United States government are an improvement on the usual type, but we must go a good deal further in the same direction to obtain a vessel meeting all the condition that such vessels must meet in sea service.

Recent acquirement of territory by the United States makes it necessary that such vessels for their navy shall have a much greater radius of action, and shall be treated differently. In fact, if a speed of thirty knots or more is aimed at, a sufficiently stanch sea-going vessel cannot be produced in the present state of the art. To obtain thirty knots with the boats now credited with that speed, a supreme effort under expert management is required, which is seldom repeated in the life of the boat.

If the thirty-knot torpedo-boat destroyer's machinery were more substantial, so that full power could be exerted at any time without risk, and if the hull were sufficiently strong to stand a moderate sea without danger, its speed would be about twenty-seven knots. Yet I venture to say that such a boat, if ordered to reach a point at sea, say, one hundred miles distant, would, under ordinary conditions, reach that point in less time than would be required by the regulation thirty-knot boat, which is said to get a horse power with less than fifty pounds of machinery.

Below I give specifications for a torpedo-boat destroyer adapted for sea service, and fit to accompany a fleet without being a source of care and anxiety to the large vessels. An outline sketch drawing is also given, showing how I would embody the necessary qualities in a sea-going vessel:

Length on normal water line	250 ft.
Extreme width	25 ft.
Depth moulded.	15 ft.
Draught of water on trial	8 ft.
Draught of water loaded.	9 ft., 5 ins.
Displacement on trial	640 tons.
Total displacement	800 tons.
Indicated horse power on trial.	7,000
Speed on trial, average six hours.	25 knots.
Radius of action at 12 knots.	3,200 knots.
Speed possible from San Francisco to Honolulu.	15 knots.
Speed possible from San Francisco to Puget Sound Naval Satation or San Diego, moderate weather	20 knots.



PROPOSED SEA-GOING TORPEDO BOAT DESTROYER.

(By courtesy "*The Engineering Magazine*".

The weights provided for are as follows:

Ordnance	36 tons.
Machinery, including water in boilers, etc.	230 tons.
Hull complete, and fittings	300 tons.
Crew and effects, including portable furniture	14 tons.
Coal at normal trim	60 tons.
Making the normal displacement	640 tons.
Co-efficient at 8 ft. draught	.448

With bunkers full of coal, there would be 160 tons more, the full coal capacity being 200 tons.

I have designed this vessel with a full forecastle extending to the forward fire room and a half poop extending to the engine room. Between the poop and forcastle a hammock berthing extends the full length. This arrangement would give very good quarters, both for officers and crew. The vessel would carry two 4-inch rapid-firing guns, one on the forecastle deck and one on the poop. The 6-pounder guns, of which there are six, would be carried on rail mounts above the hammock berthing. Castings around the two smoke pipes are carried high enough to take the inner ends of the boat skid beams. This enables four boats to be carried, with head room under them, while the casings furnish room for the galleys on deck. The conning tower is of one-inch nickel steel. There is a chart house aft of the conning tower, and a bridge above. There is also an after steering house on the poop. This covers the stairs to the officers' quarters, and carries the search-light above. This light would be controlled from the forward bridge, although I believe that control from a distance for search-lights is not in so much favor now as it was formerly. The machinists, or engine-room artificers, as they are termed in England, would occupy a space at the forward end of the poop, entering from the landing leading to the engine room, aft of which would be the ward room and officers' state-rooms. The total complement of officers and crew would be seventy-five.

I have purposely omitted all deck torpedo-launching tubes, believing that they should form no part of the armament of a sea-going torpedo-boat destroyer. The deck tubes, if there was any intention to use them, would contain charged torpedoes, which, in action where many ships might be engaged, and in so exposed a position, would be a source of dread to those on board. I have therefore arranged for two special submerged torpedo tubes in a protected compartment aft of the engine room. Owing to the limited width of such a vessel, these tubes would be designed to open on top, instead of at the inner end. I believe that there is no mechanical difficulty in so designing discharging tubes and the impeller that carries the torpedo clear of the skin of the vessel before release, as to admit of the torpedo being placed in the tube from the top side.

The sloping sides of the torpedo room would be of one-inch nickel steel. One-inch nickel-steel protection extends also the whole length of the engine and boiler compartments, giving a moderate amount of protection when the coal bunkers are empty.

In this design I have aimed at a sea-going torpedo-boat destroyer that can go to sea and remain there, without any special risk. and can maintain there a speed of twenty five knots for a few hours when such a speed is required ; that can make extended voyages, thus serving the purpose of a scout or dispatch boat whenever or wherever such service is required ; and that carries a battery which makes her a torpedo-boat destroyer in fact. Such a boat would, I believe, meet the service conditions that will surely be demanded when the present type of boat has been put to the test of sea service.

THE SHOOTING OF OUR COAST ARTILLERY AND HOW TO IMPROVE IT.

BY MAJOR-GENERAL J. F. OWEN, R. A.

Reprinted from *Proceedings of the Royal Artillery Institution*, April, 1899.

1. PROGRESS MADE IN RECENT YEARS.

Though heavily handicapped by much obsolete material, by having in so many cases to fire from obsolete guns and from works which were designated on far other bases than such as would, in these days, be admitted as sound, there is no branch of the service in which more progress has been made, in shooting with the weapons given to it, than our Coast Artillery.

It is not proposed, in this short paper, to touch upon the quesion of material, save where unavoidable, nor upon the tactical working of Coast Artillery which is necessarily so closely bound up with the guns and material supplied.

When we consider that ten years ago it was not possible to employ aimed fire from heavy guns at a ship, unless at rest or moving so slowly as to be almost in the same condition, (excepting in the very rare cases in which the Watkins position finder existed with trained men to work it), and that, at the present moment, we are able to direct an effective and well aimed fire upon vessels going at any known rate of speed, with perfect ease, and that at ranges of two to three miles, it will be seen how very great the advance has been.

2. WANT OF RAPIDITY OF FIRE.

But, there is always that horrid "But," much, very much, more requires to be done ; though we can deliver a well aimed fire from heavy guns and that at long ranges, and almost irrespective of the rate of speed of our target, yet we fail, as yet, woefully in rapidity of fire ; however much we may, in some cases, be kept back by old type guns and matériel we can and must be up and doing, and attain that comparative rapidity of fire which the matériel will allow of, and which certainly is something very much beyond what we have so far attained to; the object of this paper is mainly to point out some means, at least, towards that end.

In a most valuable paper recently published.* Major-General

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* R. A. I. "Proceedings," Vol. XXIV., No. 3, 1897.

J. B. Richardson, R. A., G. O. C. R. A., Gibraltar has ably treated of the necessity for more rapid firing and touched upon many of the points where difficulties are met with.

While laying special stress upon the absolute necessity for this increased rapidity, it is not intended, in any way, to assert that we have reached the degree of accuracy which we ought to obtain, this is certainly not the case as yet, nor should any pains be spared to improve that accuracy.

When a defect is perceived and it is wished to make it good, evidently the first proceedings should be to diagnose it, to discover the causes which have led to the defect and then to establish a procedure which will nullify or counteract them.

In this particular case the diagnosis is simple enough for an Artillerist, at all behind the scenes, but to exhibit all the causes in detail to one's readers, would be beyond the scope of this paper.

Here it may briefly be said that amongst the principal causes which have led to the question of rapidity of fire from our Coast Artillery having been, until lately, comparatively neglected, are:—

That the means necessary to enable our Coast Artillery to deliver aimed fire against rapidly moving targets, viz., instruments, adjuncts, etc.,—have only been supplied, except to a few places, within the last few years and that the tactical system established for best utilizing them for the desired end, i. e. accurate fire at rapidly moving targets,—has but recently been thoroughly imbibed by the whole of the officers and men,—if indeed we can accurately say that it is "thoroughly" imbibed even now.

Until very recently therefore we have, with the means but gradually placed at our disposal, been working up to an accuracy of fire at moving targets which has now been reached with so fair a measure of success that there are few, if any, of our coast works from which such can not be delivered, up even to the farthest ranges.

Seeing that, as before stated, there were, ten years ago, practically no works for which this could be said, progress so far has been fairly satisfactory.

3. CHANGE OF PROBABLE CONDITIONS OF NAVAL ATTACK.

Then the conditions of Naval attack, as supposed probable, against a coast work, have been revolutionized in the last few years.

When our first system of service practice from coast works and the mode of prize firing to encourage advance in the same, were introduced in 1891 — (identical with those now existing, save for minor modifications and, as to the latter, a slight introduction of the element "time") what did we picture as the probable form of attack of coast works by a Naval force?

It was that of ships steaming slowing,—say at three or four knots,—opposite the work, and delivering a slow, deliberate and not very accurate fire, from a comparatively small number of heavy guns.

Against such an attack, though rapidity of course was valuable, the factor "accuracy," which by means of the instruments and adjuncts being supplied to coast works should then have been very much superior to that of the ship's fire, assumed the greatest importance.

But what a change, since then, has come over the picture we should draw! Since 1891, the speed of men-of-war, the number of their guns, the rapidity and accuracy of their fire, and the weight of metal they can throw, have incrased enormously, far, far beyond our hesitating advances in coast armament and the supply of the instruments, improvements and adjuncts required to make them, even as they are, fairly effective.

This was only natural and what we should expect; for the first line, our Navy, must have first the advantage of modern improvements.

Now, therefore, in 1898 we draw a very different picture of a possible Naval attack upon a coast work: instead of the leisurely promenade above described, we see a squadron suddenly appear on the far horizon, moving rapidly towards the work or works to be attacked, so rapidly, that from the time each ship comes within our effective range, to the moment that it is within 1,000 yards of our works, but some fifteen or twenty minutes elapse.

In that short period of time we must effect what damage we can, for so overwhelming would be their fire at short range and so complete its accuracy, that to save useless loss of men, the garrison of the work must, as a rule, from that moment, be simply placed under cover.

This picture, of course, may be looked upon as overdrawn but, in any case, conditions have changed so completely that it stands out in the most patent manner, that "rapidity" of fire must be taken into very serious consideration and all possible means be taken by the Coast Artillery to increase it as much as possible.

4. GREAT INCREASE IN POWER OF COAST DEFENCES GAINED BY INCREASE IN RAPIDITY OF FIRE.

If from any given battery—say of four guns,—we can so increase the rapidity of fire as to double the number of "hits per gun per minute," obtained against a ship, in a given time, it is practically as though, with the slow rate now existing, we built a four gun work to supplement the first work. This would be a very costly operation in itself (and would moreover necessitate a large increase of personnel for manning the additional guns), while if a double rapidity of "hits per gun per minute" can be obtained by improved organization and training and by the supply of a few more required adjuncts or the improvements of existing ones, with the armament as it is, the cost would be but a trifle.

The very great importance therefore of doing all in our power to increase rapidity is most palpable, from every point of view, especially the financial point.

As an example, we will take a four gun battery, having four 6" B. L. guns on H. P. mountings.

The best results obtained we will say by a company, firing in each case for about ten minutes, at a record target, were ;—

a. Competitive practice, 1897-8, figure of merit, "hits per gun per minute,". . . . . 0·263

b. Competitive practice, new system, 1898-9, figure of merit, "hits per gun per minute,". . . 0.516

The offensive power of this battery shooting as was done at practice *b*, was evidently nearly double that obtained with such a shooting as shown in *a*.

If we take the hits on a ship's target as about double those gained on the "record target,"—as they certainly would be, if not more than that,—and then consider that one-half, at least, of the shot striking a ship may, on an average, be taken as effective rounds, we should obtain, in firing, say for ten minutes, at an enemy's ship :—

For *a* about twenty-one effective hits.
For *b* " forty one " "

The value of the battery's fire being thus immensely increased. To gain such an increase, and that without any addition to the number of guns or to the personnel employed, is worth taking much trouble and the overcoming of many difficulties.

5. COMPETITIVE PRIZE FIRING—EXISTING SYSTEM.

In order to stimulate the personnel to obtain excellence in the direction considered, at the time, to be that of the most importance, prizes of some description, are at present, and have for a long time past, been given in the several arms, to encourage good shooting.

In the Coast Artillery, up to the year 1891, such prizes were purely individual prizes for shooting, then practically dependent upon the individual numbers 1 who laid each gun both for direction and range.

By 1891, however, it had come to be recognized that the good shooting of a battery or company depended on the combined knowledge of their work and of their skill in it of the officers, N. C. O.'s and men, as a whole, each in their own particular portion of it, and that consequently some different method of prize rewarding should be established.

A Committee, of which I myself was President, was therefore appointed to draw up such a system for the different branches of the Artillery.

The system proposed by them was adopted and officially promulgated, and is that at present in use, with certain small modifications, as explained further on.

The system consists briefly :—

(A). Of rewarding excellence in shooting (and partially in fire discipline), by a *classification of the batteries or companies*, according to the standard reached by each, as "qualified" for "first," "second," or "third" class prize, as the case might be ; and in giving to the best shooting battery or company of a certain number grouped together (if qualified), a prize, in the shape of a badge, to be worn for a year, by every N. C. O. and man. *

This mode of reward has been found, on the whole, to work very well and to give, by the ardent emulation it causes, an ample stimulus towards the end required. Nor does there seem to be any necessity just at present to alter it.

The results of the shooting, in each year, as shown by the classification of companies and the prizes won, are published in the Royal Artillery local and general regimental orders, and are looked for with great interest by all.

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* To each group of companies is alloted a given number of prizes according to the number of the companies in the group, e. g., for a group of from four to seven companies, two prizes, in such a group, therefore two companies would win prizes, but only two, even though others might 'qualify :" the prizes being, as already mentioned, a badge to be worn by each N. C. O. and man of the company. This badge being first, second, or third class, according to the standard of classification reached by the winning company, but only one company in each group is allowed to wear a first class badge.

(B). Certain individual prizes are also given under it, viz:—

Gun-layers prizes, for these specialists.

Gunnery prizes, for a certain number of N. C. O.'s and men who pass the best examinations, practical and theoretical in gunnery. But we need not discuss these individual prizes at present, even though changes may perhaps be advisable in them, as so far, they have not been awarded for the results of actual gun practice.

6. MODE OF ARRIVING AT CLASSIFICATION OF COMPANIES.

The settling of the nature of company prizes, and the classification for and the distribution of the prizes was one thing. But to determine how the classification was to be arrived at, was quite another and more important matter.

Without going into unnecessary details, the mode laid down by the Committee, accepted by the authorities and which has been carried out since 1891, in different branches of the regiment was as follows;—

The necessary classification to be made and the prizes to be won, by "competitive prize firing," in which, as far as possible, each company, as a whole, is tested.

Certain credits also being given, towards the total which could be made, for "drill series," and for what is designated as the "fire discipline" of the company, during the manning and carrying on of the practice.

The main and principal factor however, for the gaining of credits, being the *accuracy of the shooting*. The element *time* was, on the first establishment of the system, practically neglected.

For this competitive prize firing, each company in a group of Coast Artillery, has to fire sixteen rounds on one day, from the same work as the remainder of the group are to fire from, at similar targets and as far as possible, under exactly similar conditions.

The system so adopted in 1891, though no doubt it had many defects, has certainly given excellent results and very much improved the accuracy of the shooting of the Royal Artillery in all its branches. In the mounted branches however, it was soon found that great modifications were required in the system to suit their wants, especially as their armament and equipment became rapidly improved. These modifications we need not discuss here, except to say generally, they were in the direction in which, in this paper, improvements are proposed for the Coast Artillery. The mounted branches have only been brought in incidentally and no further allusions will be made to them.

7. DEFECTS IN THE PRESENT SYSTEM.

With regard then to the Coast Artillery, the two principal defects of the system, as orginally established, and which are now patent to us all, are :—

(D. 1.) That the factor "rapidity of fire" is practically absent, though within the last year a modification has been made which brings it in slightly and tentatively.

(D. 2.) And that a company is judged, not by its practice on many occasions or throughout the whole, but by that of a single day only.

There are no doubt, many other minor disadvantages, some of which are * :—

"A. C. O. is induced to train his men more with a view to their doing well at competitive practice than to their rendering a good account of a hostile vessel."

That is to say, efficiency in shooting is sacrificed for success in shooting under limited artificial conditions, in many ways not resembling those of actual service.

"One method only of range-finding, the D. R. F. being used for competitive practice : other methods are, more or less, sacrificed to it."

It might be said more strongly, that they are very often completely sacrified to it.

"During his preliminary course of training, a company C. O. has a great deal to teach his men—is it to be wondered at that, when fire discipline is taken in hand, the P. F. is shirked in view of competitive practice, and all available time given to the D.R.F."

"One day makes or mars a company. It is classed and judged by its competitive firing (of a single day), sufficient importance is therefore not attached to the remainder of its annual practice, including shooting with P. F."

The B. C. is at competitive, and still more so at other service practice, burdened with much detail work which would not fall to his share, under service conditions.

There are many other smaller disadvantages which might be mentioned, but the above are quite sufficient to show that a change is necessary if we wish to progress, even in other things besides in rapidity of fire. As the father, more or less, of the existing system, it will be evident that I can speak freely, and without prejudice.

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* The sentences shown as extracts are taken from a very useful paper in R. A. I. "Proceedings" Vol. XXIII, No. 12, 1896, by Major (now Lient.-Colonel) P. Saltmarshe, R. A.

8. EXISTING ARRANGEMENTS AS TO DISTRIBUTION OF PRACTICE AMMUNITION.

Before entering upon an account of the important modifications it is proposed to introduce, it is necessary to explain, shortly, how the ammunition allotted to a station, for the annual practice is now distributed.

A certain sum of money is allotted annually to the station, and ammunition to that amount, may be expended, in a manner left to the discretion of the G. O. C. or O. C. R. A. at that station, who is thus very wisely left a free hand, subject to the necessity of carrying out the equipment regulations as to what is termed "station practice." This particular practice has to be carried out, from every gun in the command, at stated intervals, for the complete testing of its mounting, etc. *

The natures of service practice for which the available ammunition is employed, are as follows † :—

(*a.*) "Regimental," carried out under the immediate orders of the Lieutenant-Colonel, O. C. unit.
(*b.*) "Station" or "station and regimental combined," similarly carried out.
(*c.*) "Company practice" (including elementary). ‡
(*d.*) "Company" practice—"competitive prize firing."
(*e.*) "Company Q. F. practice."
(*f.*) "Infantry" (training as artillery), "milita," and "volunteer" practice.

Although, no doubt, more could be done as to the organization and carrying out of the practices, *a*, *b*, *e* and *f*, they do not come under the scope of this paper, which moreover does not treat, in any way, of practice with Q. F. guns of any description; there is much to be said about the latter but, for the mode of giving rewards for it and the method of judging results, it may be found wise, in all probability to borrow almost bodily from the system pursued in the Navy. It is hoped to treat of Q. F. practice in a further paper, on another occasion.

Q. F. guns may be looked upon as "shoulder" guns, and as such their practice, more or less approximates to musketry practice.

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* So far as possible this compulsory practice is made to work in with some scheme of combined practice from several works.

† See "Instructions for practice seawards," 1897-8.

‡ "Elementary" practice should not be termed "service" practice in reality, for in the "elementary" service conditions need not necessarily prevail (see "Instructions for practice seawards," 1897-98: par. 12), as it is employed for training new gun-layers and young soldiers. Whereas at "service" practice all conditions should prevail, as far as possible, such as we might look for when actually engaged with an enemy.

However that may be, it is with the ammunition expended in practie *c* and *d*, that it is proposed to deal with here, the others only coming in incidentally.

9. DISADVANTAGES OF THE EXISTING SYSTEM OF COMPANY PRACTICE.

With regard to company practice, as now carried on, experience leads one to feel strongly that a great part of it is, more or less, thrown away; and that the ammunition usually allotted to it may be far more usefully employed for instruction of the company than it is at present.

C. O.'s of companies employ it at present, mainly towards qualifying their companies for the competitive practice carried on in the narrow limits already described.

In this practice also, (more even than in the competitive), the B. C. is made responsible for the keeping of all sorts of records as to the time etc., which he certainly would not have to keep if he was firing at an enemy.

This is seriously opposed to service conditions, and also interferes sadly with his giving his undivided attention to his shooting and to the personnel and material of his work.

The records themselves, kept as they are mainly by those immediately concerned in them, are often very unsatisfactory, and frequently, though almost unconsciously, " cooked."

The subsequent mode also of criticizing the practice by written remarks only, upon the receipt of the practice reports, is tedious and wearisome to all concerned, and often results in the criticism being received by those most concerned, long after the practice has almost faded from their mind, and not as it should be, when perfectly fresh in their memories. It so loses much, if not the whole, of its possible good effect.

10. CHANGES PROPOSED IN COMPANY PRACTICE AND AS TO THE RECORDS OF THE RESULTS OF SUCH PRACTICE.

It is proposed now to make all company practice (elementary excepted), count as *competitive firing*.

In order to make this proposal practicable, it was, in the first place necessary to establish some system of record by which it would be possible fairly to compare the shooting, at any rate at each station, from the results of all the service practice carried out by them :—

(x.) Of the companies, at each station in any one year.

(y.) Of all the artillery at the station, from year to year ; and to see, in this way, distinctly what progress or otherwise, is being made.

Such a system of record was, on the writer's initiative, definitely estabilished in 1897.[*]

These records, taking in both time and accuracy, give the results by companies, of all the service practice for the year, and are ordered to be kept at every coast Artillery station.

Presuming these records to be carefully made, it is therefore now quite easy, (within certain limits,) to compare and to classify companies by the results of all their company practice in the year instead of by those of one single day's practice only.[†] This marks a great step in advance, for a means is thus provided, not only for showing what standard we reach to in any one year, but also for determining whether the shooting, as a whole, is falling behind, stationary, or progressing as it should do.[‡] We have now a distinct "figure of merit," of "hits per gun per minute," by means of which it is easy to carry out the comparisons x. and y. above mentioned. The exact mode of working out the "figure of merit" is given in Appendix II.

In order that these records of results shall as far as possible, he actually reliable, more care will have to be taken in the future, to secure absolutely accurate and trustworthy data, as entered in the practice reports, of all the company service practice carried on, and to render "cooking" impossible, by completing all the records of the day's practice in the work itself. Any doubtful point as to these data being cleared up at the time, and criticism of the practice delivered without delay.

That this criticism should be made at this time, written down on the spot and then and there communicated to all concerned, is of the *first importance*. And also that all the officers and men concerned, be kept in the work until all the records, practice reports etc. have been finally completed, in ink, the results discussed in conference and the conclusions arrived at, communicated to the officers and men of the firing company and to all those attending the practice.

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[*] See Royal Artillery R. O. of 1st. of June, 1897, directing the results of service practice to be furnished in such a manner as to give the information required and upon certain specified forms, "A." and "B."

[†] In some cases these results might be corrected by some factor for the nature of the gun and of the work fired from, as to height, etc., but this much complicates matters and is not believed to be at all essential.

[‡] It is also firmly believed that it will be further possible (within limits) in the future, to compare the shooting at different stations, one with another, with sufficient accuracy for all practical purpose. But this is in the womb of the future, though perhaps of the immediate future.

Not only will such crticism so delivered appeal to those firing much more directly than written criticism long after the event, but much time and labor will eventually be saved, at the cost of a certain amount of inconvenience at the moment, and by the application of more time, mind and effort on the day of the practice. This principle should be strenuously adhered to.

No doubt difficulties, many difficulties, will be urged ; but such difficulties will soon vanish if all willingly put their shoulders to the wheel ; they certainly have so disappeared at Malta, under these circumstances.

The manner in which the above mode of proceeding is practically carried out is explained in detail in Appendix I ; and a copy of the written critique on one actual day's practice is also given as a sample in the Appendix.

II. MEANS TOWARDS ENCOURAGING RAPIDITY OF FIRE.

To commence with our drill ; the "loading and firing," is at present much too slow, we should drill much more "against time," than is the usual custom.

The table shown on next page gives the times taken *at drill* by an average company here, and also the maximum times which should be allowed as good drill ; it is believed that these might even be shortened.

Owing to the long time, (which varies also with the packing of the cylinder,) taken to run up heavy B. L. guns with H. P. mountings, the time of "loading" by itself, should also be worked up to with such guns and mountings, and they are therefore shown separately in the last two columns of the table.

Nature of gun.	CASE ONE. To load, run up, lay and fire.		To load only.	
	Average time.	Maximum time.	Average time.	Maximum time.
9-inch R. M. L.	1 min. 10 sec.	1 min. 15 sec.		
10 " "	1 min. 20 sec.	1 min. 30 sec.		
11 " "	1 min. 30 sec.	1 min. 45 sec.		
6 " B. L.		1 min.	0 min. 23 sec.	0 min. 25 sec.
9·2 " "	2 min.	1 min. 45 sec.	1 min. 19 sec.	0 min. 50 sec.
10 " "	2 min.	1 min. 45 sec.	1 min. 10 sec.	0 min. 50 sec.

Then as to the *actual shooting* :—

The *figure of merit*, or qualification of a company as to its shooting should clearly be made upon the results of the shooting, as to time and accuracy, and upon nothing else.

It seems highly illogical to mix up, in any system of competitive prize firing, the appraising of a company by marks, (given or taken away,) for its so called "fire discipline."

For "fire discipline," after all, what ever we may actually take it to mean, is simply one of the means leading up to the end i. e., the results obtained.

The existing system in which this is done is not only illogical, but it is very unsatisfactory, for the amount of marks given or taken away for it by different umpires vary much with the individual judgment and ideas of the umpire.

Whereas the evaluating of a company solely by the results of its shooting can not vary with any personal idea of an umpire, but depends solely on the efficiency in shooting of the company firing, as shown by the results, and upon the accuracy of the recorded data, by which we determine exactly what those results are in each case.

There might of course be errors in the records, but they would be errors of fact, or of judging, and not of judgment, and would probably be common to all the series fired.

Before the element of *time* was introduced into the results by which credits were gained at competitive prize firing, there was a certain amount of ground for marks being given for so called "fire discipline," for the element of time was introduced into the latter; even then, however, it was introduced in one of the means towards good practice results, (as to time and accuracy,) and not in the results themselves, and so was faulty.

It appears advisable that the "drill series" of the existing system of competitive prize firing, (for the purpose of adjudging the value of a company in shooting,) should now altogether be abandoned.

Not that the so called "fire discipline" should in any way be undervalued, as a most necessary means to an end, but the means should not be mixed up with the end itself.

Fire discipline should be much more thoroughly carried out and much more severely judged than it is at present.

That is to say, the fire discipline of a company judged, (irrespective of the shooting of the company towards which it is a means,) in the same way as any other points of discipline and drill are judged, e. g. :—

Conduct of a company,—by the amount of crime.

The training, or discipline, in infantry work,—by the way in which a body works as a company, alone or in battalion, on the parade ground ; and so on.

In fact, the efficiency of this fire discipline, like that of any other discipline, should be judged by its effects, by the smartness and celerity of the gun drill, by the efficiency of the fire control exercised in a B. C. or F. C., by the efficiency or otherwise of the specialists (singallers, telephonists, range finders and gun layers.

All these points should be frequently tested by inspection in manning a B. C. and so on, by the Lieutenant-Colonel, whose proper function it is to enforce such discipline.

He should, much more than he does now, frequently inspect companies under his command, either informally by being present when a company drills (as a spectator without interfering,) or formally by occasional inspection, surprise and otherwise, not merely at the annual inspection.

He should do so frequently and insist upon errors being corrected and a proper standard being worked up to.

At his annual inspection he should inspect stringently the tactical working of each company, see the specialists tested, a B. C. manned, and so on, and report specifically upon the various points, the aggregate of which make up fire discipline so far as coast artillery is concerned.

But to return to the question of encouraging rapidity of fire :—

Competitive prize firing in H. M. Navy is carried out, not by the firing of a *given number of rounds*, as has hitherto been in vogue with us ; but by *firing for a given time*. This latter seems the more sound, both in theory and practice, and in adopting it, in the new system proposed in this paper, a leaf has been stolen from their book. The Royal Navy has gone far ahead in gunnery and there is many a point to be learnt from its custom and practice, by the coast artillery.

It is proposed that for each work, a *given time*, (say from ten to twenty minutes,) be laid down, (according to the nature of its armament etc.) as that for which the company practice, (i. e. the competitive prize firing,) is to last, the B. C. being allowed to fire as many rounds as he can do, during that given time.

The credits allotted and the classification made being entirely dependent upon the two factors, the "accuracy" and the "rapidity" of the fire of the company in that given time ; these two taken together, in the manner shown in Appendix II., giving the "figure of merit" of the company in its competitive prize firing of that particular day.

The same system to be pursued in judging of the value of *all* service practice. As however, in the case of *combined* practice from two or more works, there exist at present many difficulties in the way of recording results, etc., though it is proposed that the results of combined practice shall be so judged and shown against each company firing at combined practice, it is further proposed that it shall not count as part of the competitive prize firing of the company for the year.

In time to come, it is hoped that the difficulties mentioned may be overcome and that by means of some practical method of reducing the value of the fire results, from any work, and from any number or nature of guns, to a common factor, it may become possible to value a company's shooting by the results of all its "service" practice during the year, whether "company" or "combined." The method proposed by Lieutenant P. K. Lewes, R. A., * seems to point to a possible solution.

It is very clear that the mode of carrying out the competitive firing now proposed is, in its conditions, as near that which we may expect to exist if actually firing at an enemy's ship, as it is possible to be in peace practice. *This is a most important point.*

Modern conditions of naval attack seem to make it probable, that an enemy's ship will only be in the fire area of a work for a very limited period of time, say ten to twenty minutes, whether she is passing it to make a reconnaisance, or running straight in towards it to get to close quarters to make a real attack, and that during that short period, it is most imperative that a coast work should deliver as many effective rounds against her as is possible.

The conditions of the existing system of competitive prize firing by no means correspond with the above, and are indeed very artificial.

12. PROPOSED NEW SYSTEM OF CARRYING OUT SERVICE PRACTICE AS COMPETITIVE PRIZE FIRING.

The new system very briefly described below, is by authority, being carried out in the Malta command this year, (1898-99,) and so far with excellent results, on the whole, and much to the satisfation of all concerned, for it is evident that both officers and men recognize how much more nearly the practice under it, approximates to what would be their actual work in war, than the prize firing under the system so far existing.

Table Q. in Appendix III. shows the results of one days practice made under this new system, compared with the average results of the whole of the competitive prize firing of the year 1897-98 reduced to the same measure. It will be seen how far better it is than the best of that year under the existing system, and yet all concerned were quite fresh to it. We may hope for much better results, as they become more thoroughly accustomed to what is now so novel to them.

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* "Mode of obtaining a Figure of Merit, for comparing the shooting of different Companies, from different Works." R. A. I. "Proceedings," No. 4, Vol. XXVI.

It is believed that the eventual adoption of the system, for the whole of the coast artillery, (with such modifications as experience in it may show are necessary,) will tend vastly to better matters and lead to as great an improvement in the tactical working and in the shooting of that branch as somewhat similar changes have brought about in the mobile artillery.

The proposed system is but very shortly described in this paragraph to show as clearly as possible, the main points in which it differs or not from that now existing, but a full description, with all the details necessary to be known by those who would have to carry it out, is given in Appendix I.

(*a.*) *As to ammunition*:—

The necessary amount to be allotted by the G. O. C. or O. C. R. A. at the station, for "station" or "combined station and regimental" practice. For "elementary" practice, a certain proportion to be placed at the disposal of the O. C.'s companies, for assisting new gun layers to get over gun shyness, for testing gun layers etc.; while to each company will be allotted a large amount of aiming tube ammunition and electric and percussion tubes for training purposes.

All the remainder of the ammunition available, for heavy or medium guns (Q. F. excepted) to be used for *company service practice*, i. e. under the new system, *competitive prize firing*; this being divided amongst the companies at the station, as far as possible, equally, to be fired by each in a given number of practices, (the same number for each) and from the same works by the companies in each group.

The whole of this company practice *to be competitive*, and the companies to be judged and classified by the total results of this practice in the year. So that instead of the classification, prizes won, etc., depending on the results of one day's practice from a single work, they will depend upon the results of several days practice from different works, and on several different days.

(*b.*) *Mode of arriving at classification from the results of practice.*

The present credits given for drill series and for so called "fire discipline" to be abolished.

With regard to this it may be safely taken for granted that those companies which have been best drilled and which have been best trained by the discipline necessary to ensure fire control and otherwise good tactical working, will certainly, other things being equal, be those which will make the best practice.

Major-General Richardson very truly says :—

"It is a great mistake to suppose that rapid work leads to inaccuracy or that slow work ensures good shooting. In most cases good shooting and rapid firing go hand in hand in competitive practice, and training for the two should go together."

And again "The smartest will be the company which has managed to pitch most shell into the target in the shortest time available for actual practice." *

My own large experience as Commandant of the Golden Hill School of Instruction and as G. O. C. R. A., Malta, of the shooting of coast artillery leads me quite to concur in this opinion, for it has shown me that (as might only be expected) it is the company best disciplined and trained to its work and the smartest at it, which, in nine cases out of ten makes the best shooting.

The companies will be grouped as at present, those in each group firing similar series from each of the works from which they practice.

Companies to be "qualified," however, simply and solely by the results of their fire in these several series, as judged by the "figure of merit" obtained in them, *i. e.*, by the "hits per gun per minute" made in the whole of the practices instead of as at present.

The qualifying figures of merit, † classification, etc., to be, for the present, as under :—

First class, 0·25 ; second class, 0·20 ; third class, 0·15.

(*c.*) *Rounds to be fired at company practice* (*competitive prize firing.*)

The rounds will not, as at present, be limited to any given number, but will be whatever number can be fired in a given time.

A given period of time ‡ being laid down for each work from which the firing takes place.

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* See R. A. I. "Proceedings," No. 3. Vol. XXIV, 1897.

† The standard laid down for classification, under the present system, is too low; too many companies are able to qualify as first class, which makes it too common and so less valuable this is so far satisfactory as it shows that the accuracy of fire has much increased and that it has, as it were, "caught up" the standard orginally fixed upon. But it is misleading and makes companies fancy at times that they have arrived at perfection, when, in reality they fall very far short of it.

‡ The limit of time would mainly be decided upon with a view to the average amount of ammunition which a company might be expected to expend in that limit. Previous practice from the particular work should make this a very easy matter, it certainly has proved so here.

Then again it has to be considered how much ammunition will be available on the whole, for each company, and also, approximately, what number of separate practices it is intended that each company shall carry out.

With these data decided it is easy to settle upon the limit of time most advisable.

$$\text{Say Fort X} \left\{ \begin{array}{l} \text{2 10-inch B. L. guns} \\ \text{2 6-inch `` ``} \end{array} \right\} \text{10 minutes.}$$

(*d.*) *As to targets, modes of reckoning, hits, etc.*

No change in these is brought into the new system, although it is considered that scoring against a "ship" target is much sounder in principle than scoring on the Record target, which, after all, like the ship target, must often be imagined not seen, being represented by two small targets for the stem and stern of it just as with the "ship" target.

Ricochets will still only reckon half a hit.

(*e.*) *With regard to the range instrument to be employed.*

This will not always be the D. R. F. as has hitherto been the case with competitive prize firing, for the umpire will lay down the instrument which is to be employed at each practice, only it must be the same for each company of a group for the company practice from any one work.

The existing system, by which the D. R. F. is used at all competitive practice has very seriously handicapped that most valuable instrument the P. F., for naturally officers will, if possible, train their men entirely with the instrument with which the prize firing by which the company is judged is carried out.

(*f.*) *Records of practice and criticisms on the same.*

These will be all completed in the work itself on the day of the practice and the criticism orally communicated on the spot instead of the records being subsequently made up from all sorts of pencil data, often incomplete and incorrect, and the criticism dragging a slow length along through days and weeks after the practice. Both these two are serious defects in the existing system.

(*g.*) *Prizes.*

It is not proposed, at present, to make any changes in these either in number or distribution.

The above are the main points, in which the new system proposed differs, or otherwise, from that now existing. All details necessary to ensure its being satisfactorily carried out are given in Appendix 1.

There are a few points which I wish to emphasize, *à propos* to the subject, before leaving it.

1. My thanks are due to Lieutenant-Colonel J. McDonnell, R. A. (who came to Malta on promotion from the R. H. A.) and,

who, at my request, drew up a very useful memorandum for me, on the matter of practice, to which I am much indebted.

2. As to *matériel*, there is no doubt that even with the existing *matériel* and works at their disposal, Artillery officers can much improve tactical working and rapidity and accuracy of fire, by a hundred minor alterations and improvements. If they know their own minds on the subject of these and bring them clearly to the notice of the authorities—without being discouraged by delays and difficulties — they will, as a rule, find that the improvements will be eventually carried out, and that the shooting of their works will, by so much, be improved. It is proposed to show in another paper some of the many ways in which this can be done.

3. With regard to Q. F. i. e. shoulder firing guns, I am very strongly of opinion that the results of their firing and the mode of giving rewards for prize-firing, should be treated quite separately, and in a different way, from those in connection with heavy artillery.

APPENDIX I.

DETAILS AS TO CARRYING OUT THE PROPOSED NEW SYSTEM OF COMPANY PRACTICE AS COMPETITIVE PRIZE FIRING.

1.—Prior to firing at practice.

(*a.*) The company which is to carry out the practice, the work from which it will be carried out, the fixed time to be allowed for firing, and hour at which it is to commence will be notified in orders at least three days before it is to take place; (the hour for commencement should be as early as possible, for artillery sea ranges are usually most clear in the early morning.

The company which is to furnish the range party, the name of the range officer, and the place and time when he is to get his orders from the umpire will be published at the same time. *

(*b.*) An umpire (not under the rank of Major, if possible) will be selected for each group; he will be assisted, if possible, by a

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* The following is a specimen order as published for one such practice :—

(1). Service practice on the new system will be carried out on Monday, the 9th January.

Company to practice	17 S.
Work from which the practice will take place	D. Grazia.
Time allowed for series	12 minutes.
Hour for commencement	9.30 a. m.
Range officer	Lieut. J. A. P. Robinson.
" " in waiting	2nd. Lieut. A. G. Haig.
Company to furnish range party	27 S.

(2). Major C. H. Alexander is appointed umpire.

(3). The range officer will get from the I. G. a chart of the course and meet the umpire when and where he may arrange, to receive instructions.

(4). The service ammunition of the B. C. will be at the disposal of the officer commanding 17 S., who will arrange with the officer i/c sub-district regarding it.

captain or subaltern and by a small number of N. C. O.'s and men, (of a company other than that firing) for recording purposes. The above officers and men, as well as the range party, getting an overslaugh of duty.

The range officer will report himself to the umpire and receive orders from him as to the course to be run, etc.

The umpire will receive from the I. G. a filed copy of all critiques, so far made for the year, as a useful guide to him and the senior officer present at the practice ; these he will return to the I. G. the day after the practice with his report.

(*c.*) A roll of each company will be prepared at the beginning of the practice season in duplicate on the form given below; one being retained in the company and the other for the umpire's use.

As soon as the order for practice is issued, the umpire will mark off on his copy, in the column for the particular practice to be fired, the officers, men and specialists who are to man the work for the firing with sufficient reliefs for casualties and pass to the O. C. company who will similarly note on his copy and return the umpire's copy.

The officers and men to be shown by sections excepting the D. E. specialists attached (the latter entered in red) all of whom will be shown separately below the last section in columns one and two. Columns one, two and three will be filled in by the company commanders. The other nine columns will be prepared, with their headings, but will be left blank for subsequent completion by the umpire as each series is fired.

COMPANY ROLL.

Section of company or description of specialist	Rank and name.	Employed permanently and how.	1st series.	2nd series.	Remarks.
			Work. . . . . P. F.. . . . . . or D. R. F. . . . Date.		
(1)	(2)	(3)	(4)	(5)	(12)

N. B.—Columns five to eleven will be reptitions of column four for the second to the eighth series of practices.

These rolls will be signed by the company commander, and after each practice, by the umpire in column four.

In this way it will be ensured that each officer and man of the commpany takes part in one or other of the practices.

(*d.*) The officer commanding the company will arrange as to *matériel* with the officer in charge of the sub-district in which the work is. Deficiency or defects in *matériel* will not be allowed as any excuse as regards time or accuracy on the day of the practice. They will have to be made good beforehand.

(*e.*) The officer commanding the company may, if he choose, man the work at any period within two hours of the time for the practice to begin. But in any case he will have his guns loaded and ready for firing by that hour.

This, it will be seen, is quite a service condition.

2.—During practice.

(*a.*) The officer commanding unit to which the firing company belongs will always attend such practice.

(*b.*) The umpire will be in the work at least fifteen minutes before the hour named for the practice.

The range party and launch will be entirely under him, and he alone during the practice, will send them orders by signal or otherwise. He will, at the hour named for beginning (if satisfied with the target's position and rate) sound the "commence firing" and at the end of the ten minutes or other fixed time laid down for the practice, will sound the "cease firing." No round fired after the latter sound has ceased will count for the company. The guns loaded at the time will be unloaded, if possible. otherwise they will be fired at the target, by order of the umpire,

During the paactice the battery commander will give no orders by trumpet sound. The umpire will, usually, be able to arrange so that the range shall be clear for the short time allowed for the practice, but should it become blocked, he will sound "stand fast" and then "go on" when the range is clear, giving, on the whole, the specified time allowed before he sounds "cease firing."

He will order casualties but must, for any one work, give each commander the same number and nature of casualties for each series of practice, though not necessarily in the same sequence.

The umpire will cause all the necessary records, as to rounds fired, to be made in A. F., B. 79 — which he is responsible for— by himself, assistant, or time-keepers; and will also keep (or cause to be kept) notes as to any defects in, or accidents to, *matériel*;

and also as to any patent faults in drill or tactical working which affected the accuracy or rapidity of the fire.

3.—After the firing is completed.

(*a.*) The range officer will at once signal to the umpire, the range, under or over, of each round fired. * He will then land at the nearest point to the work and proceed there as quickly as he can with his range record book and the diagram of the course.

(*b.*) The umpire will go round the work with the battery commander and the latter will then direct the manning detail to wash out the guns, to clean mountings, etc., to fill up depôts, and generally to proceed as they would do in war time after being in action against a hostile ship and expecting soon to engage another.

(*c.*) The umpire and battery commander will then conjointly proceed with their assistants to complete in ink in the work itself the Practice Report (A. F., B. 269) in duplicate. The particular portions for which they are severally responsible are given below :—

Umpire :—Columns five, six, seven, eight, nine, eleven and nineteen. †

The umpire's estimate of right or left from centre of target will be entered in another column to be ruled in the report and numbered twenty.

Battery Commander :—Columns one, two, three, four, ten, twelve, thirteen, fourteen and fifteen. †

To assist in preparing these practice reports :

The P. F. operators (of P. F.'s covering the fire area of the work) will be marched down, with their reports, tables of corrections, etc., within a reasonable time.

The Gun group Commanders will complete their reports in ink and also fill in form E. as soon as the duplicate (company) report is ready and hand them all to the Battery Commander.

The umpire will have with him printed on hectographed forms, as under, which will be filled in by him in ink on the spot.

Table D.—Preventable errors.

Form A.—For that particular practice, to be filled in from his practice report when completed.

(*d.*) As soon as the whole of the above have been completed, a conference will, at once, be held in the work, of the officers taking part in the practice and of all others present. These will always include the I. G., I. R. F., I. O. M., etc.

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* Column nineteen of Practice Report can then be filled in in pencil by the umpire, pending arrival of Range Officer.

† The numbers refer to the latest edition of A. F., B 269.

The following general course will be pursued. The senior officer present will call upon the umpire to point out the results of the practice, the figure of merit obtained and the preventable errors or defects in drill or the working of *personnel* or *matériel*, as he or his assistants have noted as affecting the practice. The specialist officers, Instructor of Gunnery, etc., will then remark on any points they have observed as requiring attention. The Battery Commander, Gun group Commander, Range Officer, and Range group Commander (if any) will afterwards make their explanations or remarks on the points brought forward, every officer being allowed free expression of his opinion.

Any doubtful point, *e. g.*, as who was responsible for errors committed or as to any defect in or damage to *matériel* being thoroughly gone into then and there until a clear and definite conclusion on the same has been arrived at.

(Notes on these points will be made by the umpire and the O. C. unit to which the firing company belongs for completing their subsequent covering reports—see below.)

The records of the umpire, however, can, in no case, be impugned, they will be taken as correct as against any other data.

The senior officer present will finally sum up (putting the same in writing) giving his opinion on all the points brought forward. * He will also remark on the fire discipline of the company as shown by the drill and tactical working during the practice—this being entirely his province and not that of the umpire. (who is chief observer and responsible director of the practice, though without interfering with the actual fighting of the work). The criticism thus made will be final * as to the day's practice, unless the O. C. or G. O. C. of the district, on receipt of the reports next day, wishes to make any general remarks to be published to those concerned.

(*e.*) As soon as the conference is over the B. C. himself or through his officers will explain to the N. C. O.'s and men faults or errors committed by them, or as to defects in *matériel*, etc. He will then "replace stores" and march them home.

N. B.—Until the whole of the above is completed no officer or man concerned in the practice will quit the work.

(*f.*) Upon the same day, or at latest the next day, the following will be sent to the I. G. at district head-quarters, for the information of the O. C. or G. O. C. R. A.

By umpire:—Original practice report, A. F., B 269 complete, with his own covering report, accompanied by R. O.'s report;

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* A specimen "critique" is given at the end of this appendix.

Table D (of preventable errors); Table (new form A); G. G. C.'s report (B); G. G. C.'s Form E.

By O. C. unit (to which the firing company belongs):—a memorandum covering; the B. C.'s report on the practice; and the ship diagrams, as worked out by the C. O.'s officers.

(*g.*) The records, so completed, are filed in the I. G. s office ready for eventual transmission and for the making up of the annual report for the year, Form A for all companies being kept by him up-to-date.

No further correspondence of any sort will take place as to the practice unless, as before mentioned, the O. C. or G. O. C., R. A. wishes to send extracts of his own notes on the final critique to any officers for their information and retention.

CRITIQUE ON SERVICE PRACTICE (AS A SPECIMEN).

Date 21.11.98.
Officers of Company Major C. H. Milward and Lieut M. C. H. Bird.
Company firing 17/E.
11 series 15 practice.
Work Garden Battery.
Range instrument used, P. F. Case II and D. R. F. for dead water from P. F.
Guns 1—9·2″ B. L., 2—6″ B. L.
Time allowed for series, twelve minutes.
Average range, yards, 1,963.

General Remarks.

The weather fair but changeable, sunshine and cloud alternately; a fresh breeze from eastward cleared away the smoke quickly; on the whole a very favorable day.

There was some bungling on the part of the range officer; he could not see signals[*] but should have come in closer to find out what they were.

The eleventh round (No. 19) struck rear target and turned it over, so for the last nine rounds there was only one target to fire at.

At round seventeen[†] (A/1 6″ B. L.) the projectiles broke up in the gun.

As to adjuncts used.

See reports on practices twelve to fourteen.

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[*] It will be better for this work to have a second set of signals hoisted at Cambridge whence they can be more easily seen from the launch.

[†] One splinter apparently reached to 150 yards of target, others struck water in different directions 300 and 500 yards from the work.

The rear sighting steps of the 6″ B. L. were fixed up out of the way; at A/1 tied up with rope by gun detail; at C/1 kept so by an alteration made by I. O. M. using a special spring.

Firing by electric lanyard; one miss fire at B/1 round thirty-two, the fault of gun-layer.

As to matériel.

On the whole all worked well; at A/1 6″ the recoil was not sufficient for first two rounds owing to new asbestos packing of cylinders.

At B/1 9·2″ the recoil was very violent and did some damage due to amount of air. The air screw means of escape is quite insufficient for the purpose with this gun and seriously interferes with rapidity of practice.

Rounds lost.

(*a.*) *As to direction.*

Three rounds lost.

2nd No. 15 shot falling 35 L.
4th " 17 " " 25 "
7th " 20 " " " "

B. C. gave no deflection until ninth round (No. 22) when he gave 10 R. to A/1 6″. At thirteenth round (No. 26) he gave 10 R. to the other two guns with results four rounds L. three rounds R.

It would have been better if he had given 10 R. all round to begin with.

(*b.*) *As to range, etc.**

No rounds were lost as to this; though some only scored R=½.

B. C. gave no correction to 6″ B. L. until fourteenth round (No. 27) when he gave+50.

To 9″·2 he gave a normal correction of + 100 increasing to + 125 giving — and then to + 175 which gave +.

Loss of time.

At least a minute was lost at A/1 due to hard packing, and at B/1 (9·2″) much time was lost in letting out air by air screw for reason explained above. This was due to defect in material, also a little on account of miss fire with electric lanyard due to the gun-layer.

Service, etc.

Very good, smart and quiet.

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* It will be advisable to enter summary of range corrections and results for each service practice in Fort Record book briefly as a guide.

Lever lengthening cam lever, well applied.

Gun-layers very good at their work, one error of gun-layers as to damage of electric lanyard leads (tube).

Some minor faults in words of command, etc., as given in a/I. of G.'s report.

Mode of fire "slow" up to third (No. 15) after that "independent group salvo."

Results.

A/1 gun 8 rounds.
B/1 " 4 "
C/1 " 8 "

20 rounds in 12 minutes 17* hits, making 0·472 "hits per minute per gun." R = 1.
15* hits, making 0·416 "hits per minute per gun." R = ½.

A/1 and C/1 6″ maximum rate — 1½ minutes per round.

Average rate 1·8 minutes per round.

Times.

Practice commenced	10 h. 43′ 48″	Breaks, one due steamers on range from 10 h. 55 m., 32 s., to 11 h., 2 m., 30 s.
" ended	11 h. 2′ 36″	
Records completed for conference	12′ 40″	
Conference ended	1′ 10″	

(Initials) J. F. O., M. G.
21st November, 1898. Senior officer.†

APPENDIX II.

MODE OF WORKING OUT THE FIGURE OF MERIT.

To obtain the "figure of merit" of a company from the results of its annual practice (shown by the record of the same in the authorized "Form A" and epitomized in the "Form B") we proceed as follows:

Form A.—The results in column nine (hits per gun per minute) are arrived at by the formula:—

$$\frac{H}{T \times n} = \frac{\text{No. of hits}}{\text{Total time} \times \text{No. of guns.}}$$

Thus "X" company practice 1st series.

$$\begin{aligned} H &= 10\tfrac{1}{2} \\ T &= 29 \\ n &= 2 \end{aligned} \quad \frac{H}{T \times n} = 0{\cdot}181 \text{ (about)} = \left\{ \begin{array}{c} \text{Fig. of merit for} \\ \text{this series.} \end{array} \right.$$

Form B.—The average hits per gun per minute for all the practices of a company (filled in in column eight of that form) are obtained by the formula:

---

* One shot 17th round (No. 29) broke up. For this the average of other rounds was allowed giving it 0.75 hits.

† To be initialled here by senior officer present making the critique, with date.

$$\frac{H''}{S''} = \frac{H''}{\text{Sum}\ (T \times n)}$$. Where H″=the sum of H of each series

Thus for "X" Company H″ = 54½. Then :—

$$S''\ \text{sum} \left\{ \begin{array}{ll} \text{series } 1 & 58 \\ \text{series } 2 & 72 \\ \text{series } 3 & 42{\cdot}5 \\ \text{series } 4 & 18{\cdot}7 \\ \text{series } 5 & 66 \\ \text{series } 6 & 186 \end{array} \right\} = 443{\cdot}2 \text{ for the six series fired.}$$

$$\frac{H''}{S''} = \frac{54{\cdot}5}{443{\cdot}2} = \left\{ \begin{array}{l} 0{\cdot}123 \text{ (about) figure of merit of all the prac-} \\ \text{tice of ``X'' Company, whether ``com-} \\ \text{pany'' or ``combined.''} \end{array} \right.$$

FORM A., FOR X COMPANY, S. D., R. A.

Work and height.	Date.	Nature and number of guns.	Nature of practice.	Rounds fired.	Hits.	Time, minutes.	Hits per gun per min.	Range instrument used	Avergae range.	Remarks.
W. 129	18. 8. 97.	2, 6″ B. L. H. P.	Company.	14	10½	29	·188	D. R. F.	1821	
W. 129	25. 8. 97.	" " "	"	24	19	36	·264	"	2172	
X. 74	29. 1. 98.	4, " " "	"	16	9½	10·62	·224	"	1789	
Total averages .		8 guns.	Company	54	39	75·62	·226	D. R. F.	1927	
Y. 84.	8. 11. 97.									
Z. 89.	8. 11. 97.	1, 17·72′ R. M. L.	Combined	4	2	18·75	·107	D. R. F.	1393	
		1, 6″ B. L. H P.	'	8	7	33	·106	"	1640	
W. 129	25. 4. 98.	1, 11″ R. M. L.								
		1, 6″ B. L H. P.	"	18	6½	62	·035	P.F. III	2513	
		1, 9·2″ B. L. H. P.	"							
Grand total for all practice		14 guns.		84	54½	189·37	·123		1886	

APPENDIX III.

COMPARISON OF SOME PRACTICE UNDER THE PRESENT AND PROPOSED SYSTEMS.

The table below shows :

(1.) The average results of the competitive firing of 1897–98 at Malta, all being from Fort A.

(2.) Results of the firing of one company, the best so far, from Fort A in 1898, under the system of company practice (*i. e.*, comparative prize firing).

In both cases the guns used were 6″ B. L., on H. P. mountings.

TABLE Q.

Practices.	No. of rounds fired.	Time in which fired	Number of hits.*	Hits per gun per minute.	Range instrument used	Average range.
1	96	86½	54½	0·157	D. R. F.	1837
2	26	7½	15½	0.516	D. R. F.	2108

* At an imaginary "Record" target in both cases. Ricochet hits = ½.

TEMPERATURE DEVELOPED IN FIREARMS BY FIRING.

(SECOND NOTE.)

By M. BILLARDON, Engineer in Chief of the Powder and Saltpetre Works.

The *Mémorial des Poudres et Salpêtres* published, in 1893, (Vol. VI, p. 224) the results of an investigation of the temperatures developed in firearms by firing, made by the captains of infantry on detached service at the Esquerde powder factory, and summed up by Captains Bertrand and Laroche.

From that time till the present investigations of this subject have been pursued by the following infantry officers sent to the Esquede powder works:

* * * * * *

Messrs. Priem and d'Hallewyn, in 1894; Mantion and Painvin, in 1894; Bourillet and Cordier, in 1895; Billardon and Goustis de la Rivière, in 1895; Renard and Gondré, in 1896; Guichon and Bouvet, in 1896; Baille and Dardenne, in 1897; Blot and Rivière, in 1897.

We propose to give the results of the labors of these officers.

The methods employed in these new investigations do not differ sensibly from those heretofore indicated. It is always a question of determining experimentally:

1. The quantity of heat lost in a unit of time, on account of the contact of the air and of the radiation, by the barrel set on the rifle under ordinary conditions, and raised to a given temperature (coefficient of cooling).
2. By means of calorimeters arranged around the barrel of the rifle, the quantity of heat set free by the firing of a cartridge, and taken up by the barrel (coefficient of heating).
3. The temperature, deduced by calculation, by the means of these two elements, that the barrel must acquire in the firing of a given duration and rapidity.

The first investigations, made by Captains Priem and d'Hallewyn, Mantion and Painvin, showed that the formulas given by Captains Bertrand and Laroche were inexact for rather high temperatures. The error came from a mistake in the calculation of the coefficient of heating, principally at temperatures above 100°; so that the curve indicating the value of the coefficient (*Vide Mémorial,* Vol. VI, p. 240) as a function of the temperature of the barrel, instead of being convex upward, which would lead us to admit the cessation of the increase of heating for a temperature of about 120°, is, on the contrary, concave upward (see Fig. 4, p. 286), and is such that the increase in heating, while diminishing in value with the increase of the temperatures, must always be considered, even for the highest temperatures that the rifle may attain.

Captains Bourillet and Cordier showed afterwards that the temperatures attained by the rifle-barrel, in any given firing, could be verified experimentally by introducing a thermometer into the barrel. The cooling occasioned by this introduction is small, and, moreover, can be obviated by previously heating the thermometer to a temperature approximating that attained by the barrel. Two or three minutes are enough, and during this time the barrel undergoes a relatively very small cooling, which, besides can be easily calculated, in order to make correction for it, by means of the coefficients of cooling

Hence we have a means of checking the results of the calculations given us by the theoretically established formulas, according to our knowledge of the coefficients of heating and cooling, and if necessary, of correcting these formulas.

These very interesting verifications have been pursued by Messrs. Bourillet and Cordier, and afterwards by Messrs. Billardon and de la Rivière, who were the first to give a formula which is quite different from that of Messrs. Bertrand and Laroche, and which agrees very nearly with the one that can be definitely adopted. The experiments of these officers and of their successors at Esquerdes are to-day numerous enough to preclude all further doubts upon the practical accuracy of the formulas, which we shall give hereafter.

I. LAW OF THE COOLING OF THE BARREL.

In order to determine the law of the cooling of the rifle-barrel, this rifle is raised to a certain temperature, and then is exposed to the air. Then, by means of a thermometer placed in the bore and supposed to have, at each instant, the temperature of the barrel, the progress of the cooling as a function of the time is followed and noted.

The conclusions formerly obtained in this connection, such as are given in the notes by Messrs. Bertrand and Laroche, may be considered as approximately accurate. These officers had given for the cooling formula

$$\frac{d\theta}{dt} = 0.060\ (\theta - \tau),$$

in which θ is the temperature of the barrel, τ is that of the envelope, and t is the time expressed in minutes.

Since then it has been observed that the coefficient 0.060, which is a mean, is not constant with the temperature $(\theta - \tau)$. A slightly closer approximation, deduced from very numerous experiments, permits the establishment of the more accurate formula

$$(1)\quad \frac{d\theta}{dt} = 0.048\ (\theta - \tau) + 0.000053\ (\theta - \tau)^2$$

which we shall definitely adopt.

Under this head we shall observe that, in order to measure the cooling of a rifle-barrel previously heated, it has been recognised that it was not necessary to fill the rifle with mercury, in order to be assured that the thermometers placed inside were really giving the temperature of the metal of the barrel. It is sufficient to place the thermometer in the rifle when it is heated and let them cool together, taking care to keep the breech closed in order to avoid internal air currents. The rifie should, besides, be placed horizontally, and in the normal position it occupies in firing.

In proceeding thus, and in varying the position of the thermometer, it has been observed that the coefficients of cooling of the different parts of the firearm are not the same; the coefficients are higher toward the muzzle than toward the breech; and this is explained by the difference of thickness, or of mass, of the barrel at its different points. The above formula (1) gives the mean coefficient. If the barrel were divided into five parts of equal length, numbered from 1 to 5, from the breech towards the muzzle, the method would be to multiply the first coefficient of the above formula (1):

By 0.77 for the 1st part } Breech.
0.88 for the 2nd part }
1.00 for the 3rd part } Middle.
1.10 for the 4th part }
1.25 for the 5th part Muzzle.

So that the formula for the cooling of the first part, the breech, for example, would be

$$\frac{d\theta}{dt} = 0.037\ (\theta - \tau) + 0.000053\ (\theta - \tau))^2,$$

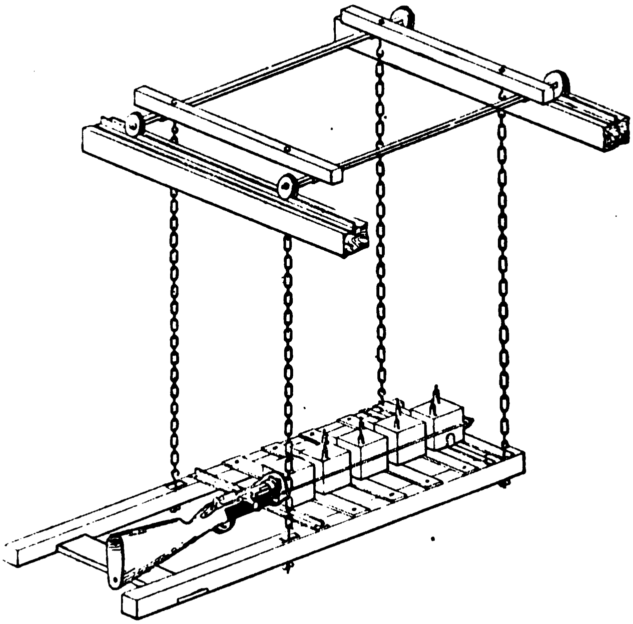
but these are only points of detail. If we give these figures, it is in order to permit, when necessary, desired calculations to be made on the different parts of the barrel, considered separately. It will generally be sufficient to consider mean temperatures, for which the coefficients of formula (1) should be adopted.

II. THE LAW OF HEATING OF THE BARREL.

The heating of the barrel, in firing a certain number of cartridges, is measured by enveloping the barrel by a cylinder full of suitable liquid, which serves as a calorimeter, collecting all the heat transmitted to the barrel by the gases and other products of the combustion of the powder. The cylinder used by Captains Bertrand and Laroche surrounded two-thirds of the length of the rifle (from the breech to one third of its length from the muzzle), and was a very imperfect calorimeter. It was very large (see Vol. VI, p. 231), and yet it had but a single thermometer plunged only into the upper part of the interior liquid.

It was found necessary to modify the apparatus, and to use smaller calorimeters disposed along the barrel. Figures 1, 2 and 3 give the general arrangement of the rifle used in the experiment and the details of the calorimeters. They are numbered

Fig. 1.



Rifle arranged for measuring the heating effect.

from 1 to 5 from the breech to the muzzle, like the parts of the rifle they envelope.

It will be observed that each calorimeter shows on the top two tubular openings for the introduction of two thermometers, one of these thermometers is let down to the bottom of the mercury filling the apparatus, the other only to the upper part of it. The difference in temperature observed between the two has varied, in the experiments, from 2° to 3°. The mean is taken in order to have the temperature of the whole calorimeter.

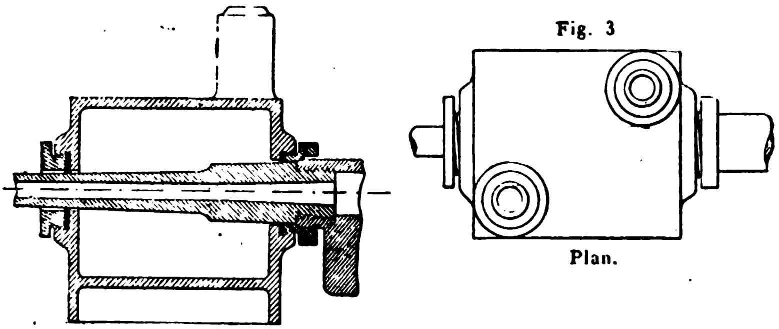


Fig. 2.

Fig. 3

Section.

Plan.

Calorimeter for the rifle.—Scale ¼.

Before firing begins, the calorimeters may be at the temperature of the outside air. They may also be heated beforehand, and care is then taken that all five are exactly at the same temperature, which is noted. A certain number of cartridges, generally fifty, is then fired within a given time; then at the end of the firing the temperatures of the calorimeters are again measured. The heating determined and the knowledge acquired beforehand of the masses contained in the calorimeters, as well as their respective specific heats permit the easy calculation of the gain in heat of the calorimeters.*

This would be the quantity of heat transmitted to the barrel in the firing, had not the calorimeter itself lost, by contact with the air and by radiation, a certain quantity of heat during the

---

* It is thought to be useless to give here the details of calculations and corrections, which, in each experiment, have led to the determination of the coefficient of heating. For the methods followed our readers are referred to the article by Captains Bertrand and Laroche, Vol. 6 of the *Mémorial*. It will be sufficient to note the masses of each of the portions of the rifle contained in the different calorimeters—information that may be of some interest:

	Grm.
1st part, breech	467.09
2nd part, breech	270.59
3rd part, middle	236.88
4th part, middle	204.99
5th part, muzzle	174.93

The specific heat of the steel of the barrel was estimated at 0.115.

whole time the experiment was going on. This latter quantity is determined moreover experimentally, and in the same manner as the cooling of the barrel exposed to the air (see first part). By adding it to the quantity of heat gained by the calorimeter, we obtain the total heat transmitted to the gun in the firing.

The calorimeter's loss of heat by radiation, should be relatively rather slight. Unfortunately, this can not be so when the calorimeters are very hot. In this case, the losses that they undergo by radiation is sometimes more than the gain they receive from the firing. So if the coefficient of heating, determined by our methods when the rifle is cold, may be considered accurate, it is quite otherwise for coefficients found at high temperatures.

There is, fortunately, a means of removing the difficulty by using the direct method of the measure of heating by means of a thermometer introduced into the barrel after the firing, as indicated in the beginning of this article, which is as follows: it is known (see Fig. 4) that the coefficient of heating of the barrel, that is to say the elevation of temperature a of the barrel, produced by the fire of one cartridge every cause of cooling being removed lowers with the temperature. This coefficient is known for low temperatures; that is, we have one point on the curve upon the axis of a when $(\theta - \tau) = 0$. We know that a must disappear when the barrel is at the mean temperature of the powder gases that fill the barrel between one shot and the next. The curve of the a's then becomes tanget to the axis of $(\theta - \tau)$.

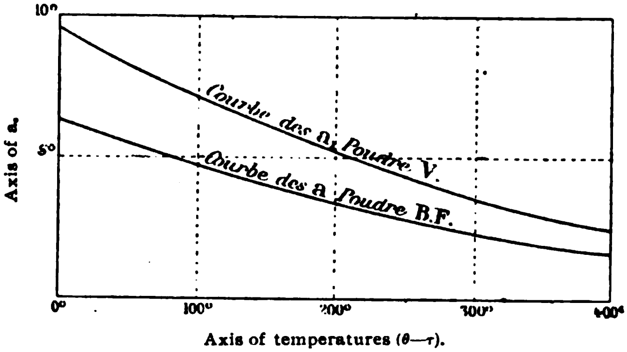


Fig. 4. Graphic illustration of the rise of temperature of the barrel for every shot fired, as a function of the temperature θ of the barrel, τ being that of the air.

We may suppose that it is practically the same as an arc of a parabola whose equation may be taken as

$$a = a\left[\mathcal{T} - (\theta - \tau)\right]^2,$$

in which aT is known, since the value of a is determined by experiment when $(\theta - \tau) = 0$.

It will then suffice if we give T various values, and choose afterwards those that will best agree with the results of all our experiments. These experiments have been many and much varied. There have been prolonged firings with the maximum rapidity practicable, that is, all heatings possible have been attained.

These determined heatings, and those that can be deduced by the formulas given below, approach so nearly that we are now able to give as definitely accurate the following values of a.

RIFLE MODEL 1886.

1. Powder *B*, charge 2.75 grm.

(2) $$a = 0.000010\left[\overline{800 - (\theta - \tau)}\right]^2;$$

2. Powder *V*, charge 2.75 grm.

(3) $$a = 0.000010\left[\overline{800 - (\theta - \tau)}\right]^2.$$

We must here make a remark analogous to the one already made upon the cooling of the barrel.

The coefficients a given by formulas (2) and (3) are mean coefficients for the entire barrel; the five calorimeters employed have permitted the determination of the coefficients of heating for each of the parts of the barrel taken separately.

These special coefficients could be obtained by multiplying the a coefficients of the foregoing formulas as follows:

By 0.85 for the 1st part, breech.
1.05 for the 2nd part, breech.
1.00 for the 3rd part, middle.
1.00 for the 4th part, middle.
0.95 for the 5th part, muzzle.

So that for the first part (breech) and for the powder *BF*, for example, the coefficient of heating would be

$$\mathbf{a} = 0.0000085\left[\overline{800 - (\theta - \tau)}\right]^2.$$

In the following calculations we shall use only the mean coefficients given by formulas (2) and (3); but it would be easy, by making use of the particular coefficients, to study separately the heating of any desired part of the barrel.

III. FORMULA FOR THE HEATING OF THE RIFLE.

For the cooling of the rifle the formula established is

$$d\theta = [\beta(\theta - \tau) + \gamma(\theta - \tau)^2]\,dt,$$

in which θ is the temperature of the rifle;

τ is the temperature of the envelope;

t is the time in minutes.

$$\beta = 0.048, \quad \gamma = .000053,$$

and for the heating produced by firing one cartridge

$$\mathbf{a} = a\left[\overline{T - (\theta - \tau)}\right]^2,$$

in which $T = 800$, and $a = 0.000010$, or 0.000015, according as BF or V powder is used.

If we designate by n the number of cartridges fired per minute, the increase of temperature occasioned by the transmission of the heat of the powder gases to the barrel will be, in the time dt,

$$\mathbf{a}n\,dt = an\left[\overline{T - (\theta - \tau)}\right]^2 dt,$$

and the variation of the temperature of the barrel in the same time. resulting from the heating on the one hand and the cooling on the other,

$$d\theta = \left\{an\left[\overline{T - (\theta - \tau)}\right]^2 - \beta(\theta - \tau) - \gamma\left(\overline{\theta - \tau}\right)^2\right\}dt.$$

The integration of this formula gives easily,

$$(4)\quad \log e(A - B)(an - \gamma)(t - t_0) = \log \frac{[(\theta - \tau) - A]\,[(\theta_0 - \tau_0) - B]}{[(\theta_0 - \tau_0) - A][(\theta - \tau) - B]}$$

e being the base of the Napierian logarithms, or 2.71828, and A and B the two roots of the equation

$$(an - \gamma)(\overline{\theta - \tau})^2 - (2anT + \beta)(\theta - \tau) + anT^2 = 0,$$

or

$$(5)\qquad 2(an - \gamma)A = 2anT + \beta + \sqrt{4anT(\beta + \gamma T) + \beta^2},$$

$$(6)\qquad 2(an - \gamma)B = 2anT + \beta - \sqrt{4anT(\beta + \gamma T) + \beta^2}.$$

By replacing in these expressions the coefficients a, β, γ, τ, by their values given above, we shall have the means of calculating easily the heating of the rifle in a given firing characterized by a number n of cartridges fired per minute, and by a duration of firing $(t - t_0)$.

Generally at the beginning of the firing the rifle is at the temperature of the air; we have then $\theta_0 - \tau_0 = 0$. In this case formula (4) can be put in a simple form, which we may indicate as follows:

$$\theta - \tau = \frac{B(c - 1)}{c - \frac{B}{A}}, \tag{7}$$

A and B having still the values given by (5) and (6), and c being given by

$$\log c = \log e (t - t_0) \sqrt{4an\,T(\beta + \gamma T) + \beta^2}. \tag{8}$$

These are the formulas (5), (6), (7) and (8) that have served to calculate the heating.

In conclusion we shall give some calculated results, and, for comparison, the verifications that have been made for each of the cases examined.

Powder tested. (charge 2.75 grm.)	Number of shots per minute. n.	Duration of firing $(t - t_0)$	Temperture at the end of firing. $(\theta - \tau)$		Differences.	
			Calculated.	Observed.	Total.	Proportional.
B F	5	10 min.	180°	151°	29°	0°.17
V	5	10	236	214	22	0 .09
B F	2	6	198	177	21	0 .11
V	8	6	258	257	1	0 .00
B F	1	14	56	49	7	0 .12
V	1	14	83	69	14	0 .17
B F	2	10	87	66	21	0 .23
V	2	10	117	100	17	0 .15
B F	3	10	117	94	23	0 .20
V	3	10	166	139	27	0 .16
B F	4	10	151	124	27	0 .18
V	4	10	206	181	25	0 .12
B F	6	10	206	177	29	0 .14
V	6	10	262	250	12	0 .05
B F	9	10	262	245	17	0 .06
B F	3	10	117	110	7	0 .06
V	2	10	117	103	14	0 .12
B F	6	10	206	177	29	0 .14
V	4	10	206	176	30	0 .15
					mean	0 .13

It is seen by this table that the experimental verifications give figures lower by 13%, on the average, than the figures of the calculated temperatures. This lowering of the verified temperatures must be attributed solely to the introduction of the thermometer into the barrel after the firing.

We can estimate, in fact, the weight in water equivalent to the length of 0.01 m. of one of the thermometers we have used at 0.18 grm., while the equivalent weight in water of the same length of the barrel towards its middle is 1.54 grm. The distribution of heat between the barrel and the thermometer must then bring about a lowering of temperature that is

$$\frac{0.18}{1.54 + 0.18} = 0.11$$

of the temperature of the barrel alone. We have found 0.13 instead of 0.11.

It will be remembered here, as in the article by Captains Bertrand and Laroche, that many different causes have an influence upon the heating of the rifle, and that it is superfluous to seek, in the problem occupying us, an accuracy that can pertain only to very special, and we may say accidental cases. The formulas indicated give *approximately*, and this point must be dwelt upon, the number of degrees of heating of a rifle in a given firing, and this is quite sufficient. In practice the real heatings may vary about 10%, generally less, in comparison with the figures indicated, which may be called the theoretical heatings.

The following table gives the theoretical heatings for BF powder in varying conditions of firing.

For the V powder the heatings would be the same for firings of the same duration in which would be used only two-thirds of the cartridges indicated in the table for the BF powder. In other words, two cartridges of the V powder give the same heating as three cartridges of the BF powder fired in the same time.

Number of shots fired per minute.	Heating of the barrel after a firing of B. F. powder of				
n.	5 minutes.	10 minutes.	20 minutes.	30 minutes.	Indefinite duration.
	°	°	°	°	°
1	29.5	47.0	70.8	83.8	94.1
2	52.4	87.3	124.5	139.9	150.6
5	118.0	180.0	229.6	243.2	248.3
10	202.0	281.8	323.7	331.1	332.7

Esquerdes, August 28, 1897.

—*Mémorial des Poudres et Salpêtres*, Tome IX.

[Translated by CHAS. H. HUNTER, Captain, 1st Artillery.

PROFESSIONAL NOTES.

ORGANIZATION AND ADMINISTRATION.

A Few Short Notes on the Administration of the United States Army in Philippines.

By Captain S. S. Long,.Deputy Assistant Adjutant-General, Hongkong.

The Hispano-American War has brought forward a hitherto neglected factor, which is bound to have a considerable influence on international questions: the vast citizen army which it is possible for the United States to get together.

A study of the American Forces operating in the Philippines well illustrates this question and is worthy of attention.

The American Army before Manila was, with the exception of a small portion, entirely composed of volunteers; and in spite of defective administrative staff and departments, insufficient equipment, and officers who possessed little, if any, more military training than the privates, these troops displayed a spirit of intelligence and obedience, combined with an individual willingness to perform their duty that might be rivalled, but could not be surpassed by the finest disciplined troops.

They might be aptly described a great Military Paradox. A body of men of magnificient physique possessing perfect dlscipline, and yet without any discipline at all.

These trsops, without previous similar experience, after a jonrney of 8,000 miles, had, practically without naval assistance, to land themselves upon an inhospitable, hostile shore, carry their stores, etc., through—on most days—a heavy rolling surf, and transport them themselves for two miles through deep mud under tropical rains to their camp, which consisted of shelter tents only. Every third day each unit spent twenty-four hours in the trenches facing the Spanish lines,—trenches which were little better than dykes, half full of water and mud, absolutely devoid of shelter from rain, and where, if a man was tired of standing, he had to sit down in slush.

Frequently at night, exposed to a galling and irritating fire from the Spaniards, they obediently complied with orders and patiently bore the enemy's fire without attempting to return it, even when occasionally their comrades were struck beside them. This restraint on the expenditure of ammunition was thought necessary by the American authorities, who feared running short of the supply.

In the advance on Manila on August 13th, although it may be said they were unopposed, still, as far as the junior officers, non-commissioned officers, and men were concerned, they were ignorant that this would be so, and their behavior left nothing to be desired. The advance took place between 11 and 12 midday, and by 5 p. m. every road, bridge, and gateway of the town was carefully picketed and held by American troops, who, the whole of that night, Sunday, and Sunday night, uncomplainingly remained in the streets under heavy tropical rains, good-temperedly carrying out the difficult and troublesome duty of preventing armed insurgents from entering the town, and carefully abstaining from coming into unnecessary conflict with the large mass of

Spanish officers and soldiery, who were rather aggressively parading the streets. The most careful enquiries failed to elicit any report of a complaint being made of any act of pillage or assault committed by an American soldier.

If conduct such as this is obtainable from raw volunteers of no experience, and under such unfavorable circumstances, then it should be borne in mind that troops of this sort are a factor to be seriously considered, particularly after they have had a few months' training.

As it may be of some interest to more deeply study the question of the organization of this expedition, it is proposed to slightly touch on the American Army Organization, showing where on the present occasion this organization may be worthy of imitation or, as is too often the case, fatal to the interests of an army in the field.

The American Regular Army, which consists of 25,000 men only, is commanded by a Major-General, the highest rank in the United States Army, any higher being conferred only by a special Act of Congress. The army is administered by nine departments, each presided over by a brigadier-general; and as all, to a very large extent, work independently of each other, the result is frequently prejudicial to the interests of the service.

These branches are purely departmental, and, as a general rule, an officer selected for employment in one or other serves the rest of his time therein, with the natural result that the staff and departments are largely out of touch with the army. Appointments to the staff are made from the army generally, usually through political influence, and in some instances even civilians, through similar influences, are appointed to the Pay Department.

I. The Adjutant-General's Department deals with all questions of drill, training, and instruction of troops, but not discipline, which is dealt with by the Judge Advocate General's Department, with the result that the senior branch of the staff and in fact all branches, and the army generally, are deficient in a knowledge of legal procedure.

II. The Inspector General's is a special department whose duties are to carry out those usually performed by a General Officer Commanding in the British service. This department sends its officers to inspect all districts and posts and every branch therein, and reports direct to the Secretary of War.

III. The Judge Advocate General's Department deals with all questions of law affecting the army and is the direct adviser on these matters. Applications for trial by a military court are, in the first instance, submitted to the Judge Advocate of the Post, District, or Force, and the proceedings before confirmation again pass through his hands. The power of the Judge Advocate, as an expert, was particularly noticeable at Manila, as every proclamation by the General Commanding appeared to require his jealous scrutiny to see that it did not infringe the law of the land or the constitution of the United States.

IV. The Quarter Master General's Department deals with clothing, camping, fuel, light, forage, and all transport, both land and water.

In the district, or in the field, the departmental head is known as the Chief Quartermaster. Each division, brigade. and regiment has its Quartermaster attached to it, known respectively by the official title of Divisional, Brigade, or Regimental Quartermaster.

This department, which may have understood its onerous duties in time of peace, and when working in its own country, was apparently without organization or initiative at Manila.

The Regimental Quartermasters were generally regimental officers without previous experience; and although all certainly worked with the utmost energy, they failed, not from want of ability, but of knowledge.

The clothing of the troops left much to be desired. It is true that the expedition was hurriedly equipped and despatched, but even so it ought to have been possible to send troops into the field with some thin clothing in addition to the heavy clothing of their own country, and certainly some effort ought to have been made to provide a better head covering than the ordinary soft felt hat, which afforded little, if any, protection from the sun. As regards this latter point, owing particularly to its being the rainy season there were no cases of sunstroke reported.

The men generally worked and paraded in their thick blue flannel shirts with turned down collar, a pair of thick canvas or moleskin trousers, and usually wore no braces, the trousers being kept up by the cartridge waist belt which held 200 rounds of ammunition in a double row.

A pair of very good canvas gaiters reaching to within a few inches below the knee and a pair of heavy boots completed this working dress.

The troops had no great-coats on shore with them, but every man had his *Poncho*, *i. e.*, a square of Mackintosh, 6 feet by 4 feet, with a slit in the middle, which could, if necessary, be fastened with a botton, and the Poncho used as a waterproof sheet. It also had some eyelet holes along the edges, so that, if necessary, two would make a fairly serviceable shelter tent.

The appearance of men walking about, or on parade, with their heads through these pieces of Mackintosh, may not be smart looking, but their utility for a variety of purposes, and the excellent shelter they gave to the man, while leaving his hands free, mark them as an article well worthy of adoption.

Every man was provided with a pair of low canvas shoes, which must have considerably added to his comfort in camp.

The requirements of an expedition at a distance do not appear to have been well studied; and many men were deficient of necessary articles, and even after the fall of Manila some were deficient of boots.

Sea Transport.

A noticeable feature of this expedition was the apparently absolute ignorance of the Admiralty and Navy as regards their duties towards the Army.

The army chartered, superintended the fitting, equipping and coaling of all transports, with the result that, when they proceeded to sea, they discovered that in some instances they were badly or deficiently found; and, after arrival at Manila, it was noticed that the Chief Quartermaster was occupied with questions regarding the coaling and detention, etc., etc., of transports more than with the necessities and requirements of the army.

The landing of the troops and stores cannot be too adversely criticised.

After the destruction of the Spanish Fleet and the capture of Cavite on the 1st of May, all steam vessels, launches, boats, and lighters that remained afloat fell into the hands of the American Navy, and as they were blockading an enemy's port, the captured launches were extremely useful for patrolling purposes, etc.

No steps appear to have been taken by the navy to sound and buoy the best landing places for troops. On their arrival, for two days some assistance was rendered to land a portion of them, but after that they were left to their own devices to do the best they could, having as means of transport an old paddle-wheel river steamer and two or three very worn out cranky launches, with a few crazy boats and lighters.

No naval transport officer was appointed, and, as a result of this lack of professional assistance, the troops suffered greatly in landing, and a quantity of valuable stores were lost in being brought ashore through the heavy surf.

In this way the whole of the ammunition for the Astor Battery was lost, and although a portion was afterwards recovered, this battery was rendered practically useless till the day before the fall of Manila. The work thus thrown on the army would, had they had an enterprising enemy, have certainly led to disaster.

Land Transport may be said to have been conspicuous by its absence. A small number of *caramatas* (a small two-wheel gig drawn by a pony) and a few water buffalo carts had been got together, but were utterly insufficient for the requirements, and what transport existed was entirely deffcient of any good organization.

The stores were landed at Paranaque, about two miles from Camp Dewey, and a large bulk of them were carried to camp through the heavy mud by the men themselves. Had it not been for the splendid energy of the troops, inspired by the magnificient spirit that premeated the whole force, the army would have been little better than an inert, immoveable mass. No portion of the whole operations deserves more praise than the sight of soldiers laboring under heavey loads, in a tropical climate, carrying their camp *impedimenta* and stores the 6, 7 and 8 miles from Camp Dewey to the city of Manila on the day following its fall.

The whole working of this department was an excellent example of the need for specially highly trained officers to administer and carry out these important duties.

A point which is more fully dwelt on in the notes on the Commissariat, or Subsistence Department, is the separation of Commissiariat from Transport as carried out in the United Stafes Army ; a separation which is fatal to the interests of the army, and from which no good results can possibly be obtained.

V. *The Engineer Department.*.—The work of this department was hardly anywhere observable. It appeared that many of its trained officers were removed from their corps for other general and staff purposes, and their places taken by both untrained and unqualified officers, with a consequent loss of efficiency·

No steps were taken to run out piers and landing stages, although such could have been easily done, the country in the immediate vicinity being well timbered, and any quantity of bamboo obtainable ; skilled labor was at hand, which, under good guidance, could have rapidly built out a serviceable pier and landing stage.

Little, if any, effort appeared to have been made to improve the roads, which, although exceedingly bad, might have been somewhat less so by clearing the ditches on each side so as to draw off the water, which in many places lay several inces deep and caused veritable quagmires.

No special arrangements were made for crossing the river between the Spanish and American trenches, fordable only at its mouth, until the day before the fall of the city, and then some rough bamboo trestles, etc., were hurriedly got together.

As far as could be observed, had it been necessary to storm the city, the loss of life would, owing to the inefficiency of this branch, have been enormous and success very doubtful.

The field telegraph appeared to be efficient and to work well, but was very slow in opening communication.

In connection with this subject the signallers were well trained and appeared to be most efficient, particularly during the advance on the city.

VI. *The Subsistence Department.*—The Subsistence Department is administered by the Commissary-General, whose chief representative in the district is known as the Chief Commissary. The organization of the department is on similar lines to the Quartermaster's.

As its name implies, it looks after all food stuffs required for rationing the troops; but as will be presently shown, it takes on its shoulders not only these requirements, but also practically constitutes itself the sutlers of the army.

As far as the troops are concerned, there is only one scale of rations, no matter where they may be quartered. But this scale admits of infinite variation of diet; and as the allowance is very liberal the result is that American soldiers are the best fed troops in the world.

The ordinary daily ration consists of—

$1\frac{1}{4}$ lbs. fresh beef.
1 lb. 2 oz. flour.
$\frac{16}{25}$ oz. baking powder.
$2\frac{2}{5}$ oz. beans.
1 lb. potatoes.
$1\frac{3}{5}$ oz. coffee, green.
$2\frac{2}{5}$ oz. sugar.
$\frac{8}{25}$ gill vinegar.
$\frac{16}{25}$ oz. salt.
$\frac{1}{25}$ oz. pepper.
$\frac{16}{25}$ oz. soap.

The above may be varied as follows:—

In lieu of fresh beef any of the following:

Fresh mutton, 1 lb. 4 oz. when the price does not exceed that of beef.
Pork, 12 oz.
Bacon, 12 oz.
Salt beef, 1 lb. 6 oz.
Dried fish, 14 oz. when meat cannot be furnished.
Pickled fish, 1 lb. 2 oz. ditto.
Fresh fish, 1 lb. 2 oz. ditto.

In lieu of flour and baking powder any of the following:

Soft bread, 1 lb. 2. oz.
Hard bread (biscuit), 1 lb;
Corn meal, 1 lb. 4 oz.

In lieu of beans any of the following:

Peas, $2\frac{2}{5}$ oz.
Rice, $1\frac{3}{5}$ oz.
Hominy, $1\frac{3}{5}$ oz.

In lieu of potatoes any of the following:

Potatoes, $12\frac{4}{5}$ and $3\frac{1}{5}$ oz. onions.
" $11\frac{1}{2}$ oz. and $4\frac{2}{5}$ oz. canned tomatoes, cabbage, beets, turnips. carrots, or squash.

In lieu of green coffee :

Roasted coffee, $1\frac{7}{25}$ oz.,
Tea, green or black, $\frac{8}{25}$ oz.

In lieu of sugar :

Molasses, $\frac{16}{25}$ gill, or
Syrup, $\frac{16}{25}$ gill.

On this particular expedition the troops drew their meat ration as follows:

6 days' fresh meat.
3 days' bacon and preserved meat.
1 days' canned salmon (1 lb.)

But so long as they drew in the above proportions, they were allowed to draw a proportionate quantity of fresh and preserved meat and canned salmon each day, so that they had bacon for breakfast, fresh meat for dinner, and preserved meat or fish for supper.

From the above it will be seen that the troops are provided with a very good ration, amply sufficient for their needs.

The rations which were provided were of excellent quality and appeared to give universal satisfaction.

An entirely new departure, one of unqualified success, was the provision of a refrigerating steamship, loaded with frozen beef and mutton.

This vessel, which contained some thousands of quarters of the above, rendered the question of the meat supply one of the utmost simplicity; and, as far as could be ascertained, the cost of provision was most economical.

The price of meat was only 5 cents per pound, and, adding on the charge for demurrage, some thirty pounds sterling per diem, a two months' supply for both naval and land forces, only cost about 5 pence per pound.

This experiment is well worthy of note, as although in the case in point the troops were close to their supply, it should be borne in mind that, as it takes some twenty-four hours to thaw out frozen meat when in bulk, troops could be supplied, with meat of this description. as long as they were not more than twenty-four hours removed as to transport from the sea, which in the case of railways would mean a considerable distance.

During peace time troops are allowed to accumulate their rations, except meat and fresh vegetables, and at the end of the month, if not drawn, the Government either credits the company with the value thereof, or the accumulations may be sold under company arrangements and the proceeds credited to a fund for the general benefit, which is expended for the purchase of luxuries such as butter, jams, etc., etc.

Advantage is very largely taken of this permission, and it frequently happens that the unit, even after the provision of all requirements, accumulates large funds, which they devote to extra comforts when travelling, etc., etc.

The department also, to a large extent, supervises the cooking, and the small "Manual for Army Cooks" issued under the orders of the Comissary-General is wonderfully complete and useful.

The contents comprise methods of cooking, cleaning untensils, choice and description of meats: how to save dripping, description of army ranges, bills of fare, savings, company funds, recipes extending to several hundreds, camp cookery, disposal of refuse, extemporised stoves or cooking places, description of field ovens, bakehouses, etc. Hints regarding water and wood, filters, and much other useful information. A point which was particularly noticeable was that there was no provision made for the issue of either a rum or porter ration; and as regards the former, the sale of spirits in any shape or form is absolutely forbidden by Army Regulations.

It was stated that it had been found that troops were effective and kept their health better when deprived of all alcohol, but well fed. At all meals the soldier had abundance of excellent coffee, and with the same beverage he invariably filled his water-bottle. The American soldier is an adept at making coffee, and a drink from his bottle is always refreshing and patatable. Frequent drinking of liquid, even water, is strongly discouraged, it being held that once a man gives way to his thirst, he is useless for any further arduous labors that day.

The instructions as regards the preparation of meals on arrival in camp differ somewhat from that usually followed in the British service, it being laid down that only a light meal of a little fried bacon or some other easily provided article is to be served at first, and should be ready within half an hour after the cooks reach camp. The heavy meal is served at a later hour.

The point before mentioned, that the department constitutes itself the sutlers for the troops, appears to be an entirely new departure from the custom of other countries.

Practically the Subsistence Department provides at every post, in charge of the Commissary or of a Commissiariat representative, a large store of articles which can only be accurately described as a well stocked provision shop, and of considerably more variety and better quality than the average Regimental Institute in the British service.

Many descriptions of tobacco, cigars, soap, stationery, etc., are kept in addition. All or any of these articles are sold to the troops at the actual cost to Government at wholesale prices at the place of production, the cost of carriage and transport being borne by the State. Officers are also at liberty to purchase at these stores anything they may require for their own or family needs.

As soon as Manila fell, stores of this description were at once opened and a number of Jewish and other camp followers, who had come there naturally expecting to reap a rich harvest, found themselves over 100 per cent. undersold by the Government.

It was stated that until the introduction of this system endless trouble resulted from complaints by posts and detachments in out-of the way places that they were unable to obtain goods, or requests for extra allowances to meet the enhanced cost of living at such stations.

This system appears good and undoubtedly gives great satisfaction and contentment to the troops, and it is stated that in the long run the Goverment is the gainer by having little difficulty in recruiting, no demands or agitations for extra allowances, and a general contentment with their lot on the part of the officers and men serving.

The provision and maintenance of supplies is provided for by appointing a number of purchasing Commissaries, to whom the Commissaries of Districts or Posts send their requisitions each month, except when, owing to climatic reasons, there is a difficulty in keeping up a continuous supply, in which case supplies are forwarded at the most convenient season of the year.

Contracts are only made for short periods, usually one month, and the general custom is to call for tenders by advertising in the newspapers. The system of accounts appears simple, and the work of the department is as far as possible, run on general business principles.

The great defect in the department, which it is considered would be disastrous in any extended operations, requiring rapid or continuous movement of troops, is the separation of the transport from the control of the Commissariat Officer.

If it be accepted as an anxiom that to be a good Commissariat Officer, a man must have an intimate knowledge of transport, and *vice versa*, then the United States' system must result in failure.

That transport should always be subversive to Commissariat, being simply a means to an end, was noticeable at Manila. The subsistence had everything that the troops could possibly want, but no means of taking it to them, and had they not helped themselves by carrying their own supplies, they would have had to go without.

VII. *The Ordnance Department.*—This Department did not appear to be much *en evidence* during the operations, and no opportunity occurred for observing its work.

A point which is fatal to the interests of the country is that there is no such organization as an ordnance committee to decide on the armaments, rifles, and weapons to be used by both naval and land forces.

The navy and army have committees of their own, who work quite independently of each other, and, as a consequence, there is no interchangeability of weapons between the services.

Both the navy and army have lately introduced magazine rifles, but of different calibre, that of the navy being the smallest of any modern weapon in use.

The regular troops were armed with a new magazine rifle, the Krag-Jorgensen, and short sword bayonet very similar to the Lee-Metford. The volunteers were armed with the obsolete Springfield and long bayonet.

VIII. *The Medical Department.*—Considering the hurried way the expedition was despatched, this department appeared well equipped and though at no time were they put to any great strain, still the work they had to do was well and excellently performed.

The sick were accommodated in light marquees, six men to a tent, bedded on a folding camp bed with wire wove mattress, 2′ 6″ width, a blanket, pillow, also a bedside table and chair, the space between the beds about 2′, any extra bedding or blankets being brought from his unit by the patient. The system adopted at Manila was that surgeons of the regular forces were employed with the brigade and base hospitals, and volunteer medical officers did duty with each regiment or unit.

No man was taken into the hospital unless his state was such that, in the opinion of the medical officer, he required special treatment or diet, otherwise he was treated in his own regimental camp and performed such duty as the medical officer considered him fit for.

The hospital appeared to be very well found in the way of medicine, drugs, instruments, and appliances. The medicines and drugs were made up in the most portable form, such as compressed tabloids, etc., and the dressings, etc., were in the handiest shape, and in packets ready for immediate use.

It speaks well for the skill of the department that they were completely successful in a large number of cases of abdominal wounds.

The health of the troops was extraordinary, and was a subject of constant remark. Out of 8,000 men who were in camp before Manila only 124 were left behind sick when they advanced on the town on the 13th August, and of these more than one-half were wounded. The following day—Sunday—the sick were moved into the town and the greater portion walked, as there was only transport enough to carry the bad cases. If the spirit of the troops was excellent, it was even surpassed by that of the medical branch, who in spite of a defective transport and many other difficulties, always had their hospitals as complete and efficient as it was possible for human ingenuity to make them.

IX. *The Pay Department.*—This department performs similar functions to that in the British service, except that they deal with and decide all questions affecting the pay, etc., of the army, and are quite independent of the Quarter Master General's Department.

It committed a great error in bringing to Manila over a million and a half of dollars in gold for the payment of the troops. The consequences were that the men found great difficulty in getting change and lost considerably by the natives refusing to see any difference between an American gold dollar and a Mexican or Manila silver dollar, although the former was in actual fact worth slightly more than double the latter.

—*The Journal of the United Service Institution in India*, April, 1899.

ARTILLERY MATERIAL.

Quick-Firing Field Gun Carriage.

The characteristic feature of the field carriage illustrated below consists in the method of taking up the recoil. All parts of the carriage are free to recoil except the hydraulic buffer AB, in Figs. 1 and 2, which is placed between the side cheeks of the trail. The front end of the buffer piston is attached to the front end of the carriage, and a strong spade is fixed to the rear end B of the hydraulic cylinder. The cylinder is further connected to the rail by chains. Around the part of the piston-rod which projects outside the hydraulic cylinder is placed a powerful spring, so that when the rod is forced into the cylinder the spring is at the same time compressed. Fig. 1 shows the brake at full length, before action beneath the trail. Fig. 2 shows the brake compressed at the instant after recoil.

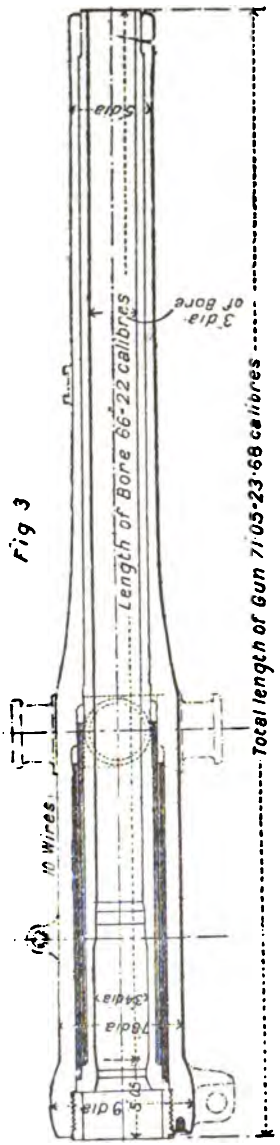
The trail is of special form and length, so as to slide freely back and obviate all "jump" on firing. The spade is forced into the ground, thereby arresting all movement of the cylinder rearwards; but the trail, being free to move to the rear, forces the piston-rod into the hydraulic cylinder, thereby displacing the liquid, at the same time compressing the powerful spring. After the energy of recoil has been absorbed, the part stored up in the spring serves to run the gun forward into the firing position again. The gun is connected by trunnions to the top carriage C, which is pivoted to the front part of the trail, so that it can be trained through an arc of 6°—*i. e.*, 3° on either side of the mounting—thus permitting of small adjustments in laying without any movement of the trail.

If required, the hydraulic buffer can be removed in about one minute. The mounting may then be used as an ordinary field carriage, and the recoil, which will then be about 7 feet, being checked by means of ordinary shoe brakes applied to the tires of the wheels. A rate of fire of twelve aimed rounds per minute may be obtained with the use of this mounting.

The advantages claimed for this system are :—1. An efficient method of absorbing the energy of recoil, and returning the gun to the firing position without disturbing the laying, and without subjecting the mounting to any excessive strain. 2. The combination of a quick-firing gun with a light construction of mounting, which is due to the length of recoil and to the mass of the recoil parts. 3. A quick-firing system suitable for all service conditions. 4. Simple and efficient means for traversing and elevating, without having to move the trail. 5. The lightest possible type of mounting, by which its "mobility on service" is not lost in combination with a field quick-firing system. The result is entirely due to the distance allowed for recoil, and to the fact that all parts of mounting, except the cylinder, are free to recoil.

The breech mechanism is opened or closed by the horizontal movement of a hand lever A, so that the same action rotates, locks, or unlocks the breech-plug B, and swings it around the pivot on which it is mounted. The arrangement consists of a link, one end of which is pivoted on a pin projecting from the rear face of the breech-plug, so that the link works in a place parallel to the breech face of the gun; the other end of the link is pivoted to a short crank which is mounted on the plug carrier, and around the boss of this crank are formed skewgear teeth. The hand lever for actuating the breech mechanism is pivoted on the plug carrier, and moves in a plane at right angles to the breech face of the gun. Around the boss of this hand lever is fitted a skewgear wheel which gears with the skewgear teeth, formed on the boss of the crank. The whole is arranged and proportioned in such a manner that when the breech is closed the hand lever lies close up to the breech face of the gun, also the centers of the link and crank are so arranged that when the breech is closed the center lines of the link and crank form a nearly straight line, the pivot joint of the link and crank being a little past the dead center, thus forming a locking point. This arrangement of centers and pivots, together with the relative lengths of the link and crank, provide great power when opening or closing the breech. On swinging the hand lever away from the gun when opening the breech, the crank moves the link past the locking center a short distance without causing any perceptible movement of the plug. The further movement of the hand lever causes the crank to turn, and by means of the link rotates the plug, at first very slowly—thus obtaining great power—and then more rapidly until it becomes

Fig 3


5 dia
3 dia of Bore
Length of Bore 66·22 calibres
Total length of Gun 71·05-23·68 calibres
10 wires
3.5 dia
7.8 dia
9 dia
5.45

78·2 MM. Q.F FIELD GUN—SECTION

unscrewed, the carrier then moves with the lever swinging the plug clear of the gun.

The firing gear is arranged for firing by electricity or with percussion tubes, and is operated by the link of the mechanism, so that at the first movement to unlock the breech-plug, it becomes impossible to fire the gun. An extractor is fitted to this firing gear, which automatically ejects the empty tubes during the opening of the breech mechanism. A retaining catch, automatically worked in connection with the extractor, prevents the tube from being jerked out when closing the breech. The breech-plug is of similar construction to that described for the 12-inch breech mechanism; the plug in this case,

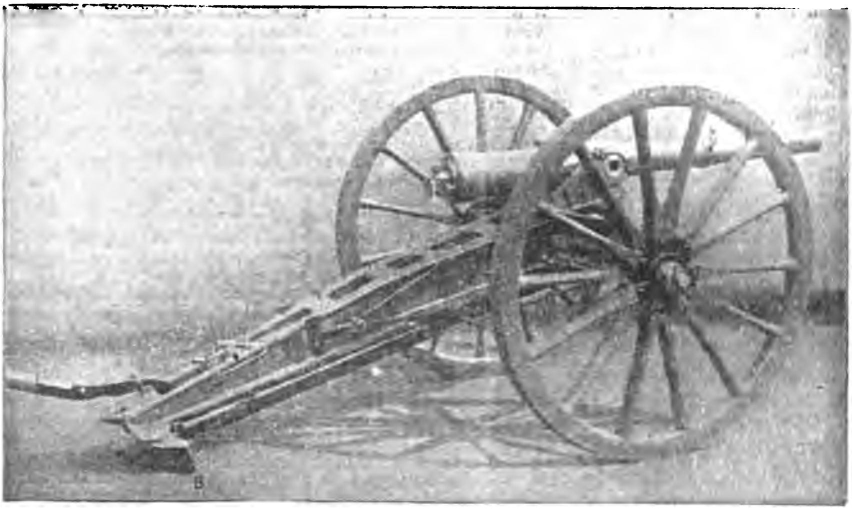


Fig. 1—Vickers 76.2 mm. Q.F. Field Gun.

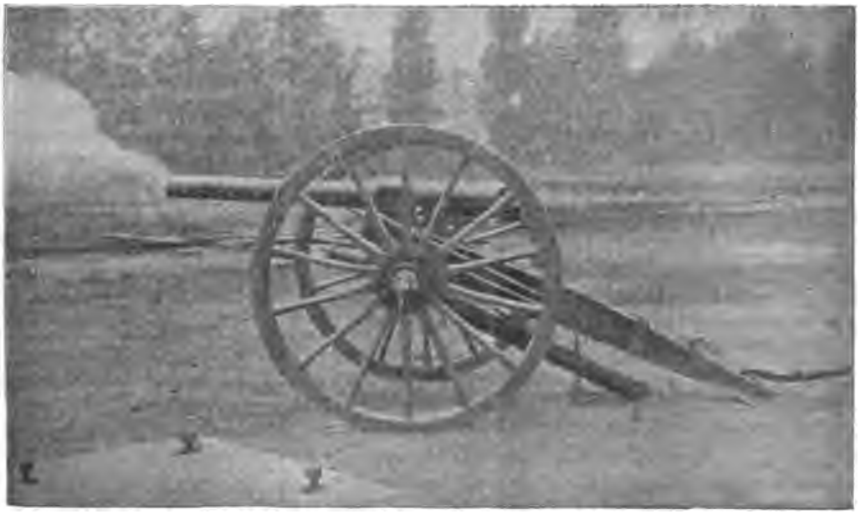


Fig. 2—Vickers 76.2 mm. Q.F. Field Gun Firing.

being divided into six segments, has two-thirds of its circumference threaded and useful for meeting the strains on the breech. The chief advantages claimed for the mechanism are the small number and accessibility of the parts.

This gun, Fig. 3, is of steel and wire construction, and is 22 calibers long in the bore, the total length from the breech face to the muzzle being 5 feet, 10.15 inches. It is constructed with a strong inner tube, round which wire is tightly wound, the tension varying in successive layers according to the method usual in the manufacture of these guns. The wire extends over the chamber and that portion of the bore where the highest pressures are experienced. The wire is then covered by a steel jacket, which extends the whole length of the gun, and is connected by shoulders to the inner tube at the chase and muzzle. At the breech end a bush is screwed into the jacket, holding the inner tube in position. The bush is screwed internally to receive the breech-plug of the mechanism. On the jacket are formed trunnions, by which the gun is supported in the carriage. The chief advantages are that the gun only consists of two distinct parts, and that the jacket extending the whole length of the gun ensures greater girder strength. With 14 ounces of cordite for a charge, and using a 12.5-pound projectile, a muzzle velocity of 1580 feet per second, and a muzzle energy of 216 foot-tons, can be obtained.

—*The Engineer*, March 10, 1899.

FORTIFICATIONS.

The Water-Front Defenses* of Santiago.

Extract from Report of Lieutenant-Colonel H. D. Borup, United States Volunteers, Chief Ordnance officer, on the Spanish Armament of the Defenses at Santiago De Cuba.

The harbor or bay of Santiago may be roughly compared to the human leg, from the knee down, in the act of walking, just as the toes are leaving the ground, the instep being well raised. The town itself, being situated just below the knee in front, is therefore completely hidden, the land on this side being high, as well as that on the other side at the entrance of the harbor.

Continuing the simile, if defenses be placed on either side of the foot and at the instep, a strong line is occupied. On account of the narrowness of the port at this place guns not at the entrance have a very limited field of fire, and practically could only be employed against ships in the act of coming in. The defenses naturally arrange themselves into two classes, the outer and the inner group.

The former comprises Morro Castle, the battery east of it, both on the eastern bank at the entrance, and Upper Socapa on the western side.

The inner group is made up of the Estrella Battery, those at Lower Socapa, St. Catalina, Punta Gorda, and Punta Blanca. The second is on the west; the other three on the east, the latter being well up the bay, near the southern edge of the city.

OUTER GROUP.

MORRO CASTLE.

Morro Castle is an ancient structure, valuable as an addition to the scenery, but worthless as against heavy guns. The Spaniards evidently took this view, for no firing has probably been done from it in years. Except as noted below no guns nor carriages are in position. Those mounted consist of five bronze mortars and two siege guns, all on the upper terreplein or roof of the castle.

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* Exclusive of torpedo lines.

There are three 13-inch mortars, made in 1724, 1733, and 1737, and two 9.5-inch ones, cast in 1780 and 1781.

The two 24-pounder siege guns are mounted on old wooden carriages and date from 1748 and 1755.

In passing it may be noted that the castle suffered little damage by the bombardment. The walls are thin and the holes made are clean.

EASTERN BATTERY.

Recognizing the uselessness of the castle and the importance of the site, the Spaniards constructed a battery a little to the east for seven pieces. The first five have the earth revetted with filled barrels. The protection for the other two is a row of square boxes, 2 feet 6 inches high, having on top a single row of ordinary barrels all filled with concrete. Total height, 5 feet. In front of the boxes for about one-half the length is a double row of sacks similarly filled.

The magazine, a temporary wooden shed, is a little in rear on the reverse slope of the hill, and is connected by trenches with the different emplacements.

The pieces are obsolete converted muzzle-loading rifles, five being bronze 6.3-inch guns and two cast-iron 8.5-inch howitzers. The former have three wide grooves and the latter six. The guns date from 1718, 1768, 1769, 1779, and 1783. I did not notice any dates on the howitzers, but they are obsolete and go back to the time of studded projectiles, which were the only ones employed here.

The carriages are old seacoast mounts and were not intended for these guns, as the trunnion bed is too large. An attempt was made to remedy the defect by putting rings on the trunnions, none of which fit. Piece No. 2 has none, though there is a difference of 2 inches in the diameter of the trunnion and its bed. Cap squares are not provided for.

The projectiles are poorly made, point fuse, cast-iron affairs, with three or six studs in one or two rows each. Some have hemispherical heads.

Black prismatic powder, with several holes, made in 1887, was employed. Piece No. 1 was dismounted by a navy projectile. I do not think it was hit directly, as neither it nor the carriage has any mark that I can find. The epaulement is demolished, and the concussion may have knocked the gun and top carriage off, as neither were strongly secured. This is the only piece dismounted by the navy.

UPPER SOCAPA.

The battery at this point consists of five pieces, the two on the right being navy 6 3-inch B. L. R. Hontoria guns, aud the others 8.5-inch howitzers, the same as at the Eastern Battery. The earthwork in front of the former is well made, being formed of bags of concrete 15 feet thick at top; the height above the emplacement being 3 feet. The protection given the other pieces is slight. No. 1 is composed of boxes and one row of barrels; No. 2 of boxes only; No. 3 has nothing. Barrels and boxes are filled with concrete. The guns are mounted on Vavasseur carriages. Both were taken from the *Reina Mercedes*, sunk not far from the *Merrimac*.

One of them was rendered useless by a navy shell hitting the shield near the junction with the right cheek of the carriage, knocking a small piece out of the former and cracking the latter.

A more or less accurate approximate estimate of the number of rounds fired from these guns is given by the copper cases containing the powder found in the magazine. There are 26 of these, each holding 6 charges, or a total of 156. One hundred and nineteen are left, which would make 37 rounds fired.

Several navy shells lie close to the magazine. Had any of them exploded the damage would have been great.

INNER GROUP.

About a quarter of a mile from the entrance on the east and west sides, respectively, are the batteries of Estrella and Lower Socapa.

ESTRELLA.

Estrella resembles a short length of a mountain road with a steep hill at the back and a sharp fall on the other side, protected by a low masonry wall about 3 feet thick. Two howitzers, similar to those already described, form the armament here. A navy projectile knocked in the roof of the shell room, but no other damage was done, though several round shells filled and fused are there.

LOWER SOCAPA.

Opposite Estrella, and not far from the water, is a weak breastwork, mounting four 1-inch Hotchkiss revolving cannon, and not far away is a 2.5-cm. rapid-fire Nordenfelt. A 5-cm. gun of this make was installed in this vicinity but can not be found. All of these were taken from the *Reina Mercedes*.

Higher up, between this and Upper Socapa, are emplacements for four light pieces, never occupied.

ST. CATALINA FORT.

St. Catalina Fort is a diminutive walled inclosure close to the water edge. It is about 50 by 30 feet, and appears to have been long since abandoned. No ordnance of any description is there. The rear wall is demolished, probably by a navy shell.

PUNTA GORDA.

Father up the bay, and directly opposite the entrance, is Punta Gorda, on which the Spaniards mounted four pieces. Two 6.3-inch Hontorias, similar to those at Upper Socapa, are mounted behind well-constructed earthworks at different levels, the upper one being about 50 feet or so from the crest of the hill.

According to the method employed at Socapa these guns were fired four or five times.

On the summit of the hill and a little to the east four pits are made, two only of which are occupied. The armament here is two 6-inch B. L. R. howitzers made of compressed bronze, mounted on iron siege carriages, with recoil cylinder, one end attached to the platform.

PUNTA BLANCA.

This point is defended by a semicircular brick wall 6 feet 6 inches thick at top. It has emplacements for six guns, though only two are mounted there at present. They are bronze, 4½-inch, muzzle-loading, smoothbores, cast in 1775. The carriages are of the seacoast type, and are made of wood now in a state of decay.

Résumé.

Before the outbreak of hostilities the port defenses of Santiago consisted of four antiquated forts or batteries, of which one, St. Catalina, was abandoned, and a second, Punta Blanca, from its position, useless. Of the other two, Morro Castle constituted the outer line and Estrella the inner one. The armament of the former consisted of five ancient mortars and two siege guns, and the latter of two obsolete cast-iron howitzers, all of feeble power.

After war was declared four batteries were hastily improvised, all of weak profile.

Including all forts and batteries, the number of guns may be thus stated;

OBSOLETE.	
Bronze muzzle-loading smooth-bores:	
Guns—	
6-inch	2
4½-inch	2
Mortars—	
13-inch	3
9½-inch	2
Muzzle-loading converted rifles:	
Bronze guns, 6.3-inch	5
Cast-iron howitzers, 8.5-inch	7
MODERN.	
Steel breech-loading rifles, 6.3-inch	4
Bronze breech-loading howitzers, 6-inch	2
Revolving cannon, 1-inch	4
Rapid-fire:	
1-inch	1
2-inch	1
Total	33

Or 21 obsolete and 12 modern pieces, and of the latter 4 only are of comparatively high power.

The exterior line consisted of 17 obsolete and 2 modern pieces, the former being furnished by the Spanish war department and the latter by the navy department. The bold front put up by the former seems to have been effective. The real strength, however, lay in the guns taken from the *Reina Mercedes*, so that the duel between the fleet and land was practically fought by the navy of both powers. After one of these guns was disabled by its carriage being rendered hors de combat, the outer defense was really confided to a single piece.

The defenses of Santiago constitute a veritable artillery museum. If there are any lessons to be learned from the naval part of the campaign, one is that if a nation does not in peace have a thoroughly equipped information service, it runs the risk of having its fleet immobilized when such action may be unnecessary.

—*Report Chief of Ordnance*, 1898.

WARSHIPS AND TORPEDO BOATS.

The St. Louis as a Transport.

By Captain CASPAR F. GOODRICH, U. S. Navy.

The exceptional credit won by the *U. S. S. St. Louis* in the transportation of troops during the late war with Spain is due to several concurrent circumstances.

In the first place, her commanding officer, the writer, had, in 1882, made a trip on board of a chartered trooper in the Tel-el-Kebir campaign under General Sir Garnet Wolseley, and he had studied the question of how British soldiers are conveyed in merchant steamers hired for the purpose and temporarily equipped. He had but to recall a former most interesting and valuable experience and to consult the official report on the subject to recognize the imperative necessity of making certain preparations and of establishing an orderly method of procedure in advance. Of these preparations, adequate water closet accommodations are first in importance. Twenty men to one hole is a barely comfortable but not luxurious ratio; over fifty men to one hole is a ratio bordering on the distressful. About a dozen extra seats were provided in the *St. Louis* to reach the former proportion.

Secondly: In the design of the *St. Louis* thoroughly complete arrangements had been made for the reception and care of seven hundred and odd emigrants. If the troops to be carried did not exceed that number, practically nothing was needed in the way of fittings.

Thirdly (and this is a most weighty consideration): The organization and routine of the ship as a trans-Atlantic liner had been retained—unaltered in any particular. If the soldiers could be regarded and treated, in the main, as steerage passengers, the personnel of the vessel would encounter no new or unsolved problem. It would indeed be doing afresh what it had already done scores of times.

Fourthly: The *St. Louis* had just brought north, as prisoners, Admiral Cervera, a lot of his officers and men (about seven hundred in all), had had no untoward occurrence on the voyage, had nursed a hundred and fifty sick Spaniards and had landed safely in the United States every man who had come on board in Cuba. The experience was both recent and useful, singularly opposite, indeed, to the next duty she was called upon to perform.

Fifthly: The chief officer under the old régime (who later received, by the way, a temporary commission as lieutenant in the United States Navy) was a man of unusual ability and energy. Fortunately, also, he had the details of the British method of moving troops by heart, having many times served on board of chartered steamers employed in this special service. My indebtedness to Lieutenant T. G. Segrave is very great. I am glad of this public opportunity of acknowledging the obligation.

Lastly: In Commander W. G. Randle, U. S. Navy, previously and now again the Commodore of the American Line, and in his subordinate officers of the St. Louis, I had a set of capable, zealous, courteous and untiring associates who seemed the happier for each new demand upon their time and powers. I can wish no one greater good fortune than to command so fine a ship and to have her manned by such readv, trained and resourceful officers, seamen, engineers, and stewards as served with me last summer. I am thus frank in detailing the advantages under which I labored, because I think it would be unfair to claim that the conditions were in the least normal. I may add that, having at my disposal extraordinary facilities for the work to be done, I also had the wit to adopt and utilize them without change.

On receiving directions to be ready to take troops from Hampton Roads to Porto Rico, I naturally did everything in my power to have the orders changed and to save the ship from what seemed to us all so ignoble a fate. My efforts were in vain. In the meantime I requested the officers attached to the *St. Louis* to submit to me written suggestions as to the preparations to make for receiving and caring for the soldiers; also as to the rules to be established for the control and discipline of so large a body of men. In these suggestions Lieutenant-Commander N. J. K. Patch was both fertile and helpful. I may here remark that the *St. Louis* was operated on mediæval lines, there being a navigating branch; the original merchant steamer organization with Captain Randle and his chief officer at the head; and the military branch to work the battery, consisting of some forty-odd marines under Lieutenant A. W. Catlin, U. S. M. C., also Ensign F. R. Payne and some naval cadets of the present third class at the Naval Academy, the whole presided over by Lieutenant-Commander Patch. Quite a story might be told of how this ancient idea worked in the nineteenth century.

The recommendations of the officers of the *St. Louis* were then considered by me, and Mr. Segrave's fund of information drawn upon to a large extent. The result took definite shape in the following instructions, which were printed in large clear type and issued, one copy to each officer serving with the troops expected, and one to every other officer who, on account of his duties, etc., should have knowledge of them:

INSTRUCTIONS TO TROOPS, U. S. S. ST. LOUIS.

All stores, baggage, etc., to be sent down to the ship at least one day in advance of troops, and four day's rations to be stored in ration room.

Troops to be supplied with one day's rations before embarking.

A full list of officers, the number of men and distinguishing letters of each company, also a list of officers' servants to be supplied to ship as soon as possible.

Each servant will be supplied with a distinguishing badge to be worn at all times.

Troops to be marched on board in companies, to stow their rifles in port lower steward's quarters, (*a*) and then to be marched to the section prepared for them and bearing the letter of that company—each section will be marked with company letter and regiment.

Twenty men will be appointed to serve out rations; no others will be allowed in ration room.

An officer of the day will be detailed by the officer in command of the troops. He will be responsible for the behavior of the men, cleanliness of quarters, etc., and will report any irregularities to the chief officer.

One officer will be detailed to take charge of each compartment allotted to troops for the purpose of maintaining cleanliness and order, and will see that his compartment, w. c.'s, etc., are ready for inspection by 10.30 A. M.; he will be held responsible for same to the officer of the day.

An officer will be with each company when rations are being served out.

Four night officers will be detailed who will relieve the officer of the day and be responsible for the behavior of the men during the night. They will make a complete tour of inspection through the compartments every two hours, accompanied by an officer of the ship, and report any irregularities to the chief officer.

Reveillé to be sounded at 4.30 A. M., when the men will roll up and stow their beds and come on deck, where they can have the use of the hose until 5.30 A. M.

The first mess-call will be sounded fifteen minutes before meal hours and will be for mess formation, when the men in each section will fall in under their company officers, and at the second call the men of the forward sections will march along the port alley way, pass through the passage on the fore end of the ration room, receive their rations and return to their sections through the star-board alley way. The men of the after sections will pass through the port after entrance, receive their rations at the after end of the ration room and return to their sections through the starboard door (*b*).

First call will be sounded at 9.30 P. M., and taps at 10 P. M., when all the men will be in their quarters for the night (*c*).

Each section and each w. c. will have the company letter and regiment (*d*) painted on it so as to avoid confusion, and notice boards will be placed in different parts of the ship to facilitate the movements of the troops (*e*).

Drinking water will be supplied from a fountain in each square (*f*).

MEAL HOURS, ETC.

Reveillé at 4.30 A. M.
Washing, 4.30 to 5.30 A. M.
Mess formation, breakfast, 5.30 A. M.
Second call, 5.45 A. M.
Inspection, 10.30 A. M.
Mess formation, dinner, 11.15 A. M.
Second call, 11.30 A. M.
Mess formation, supper, 4.15 P. M.
Second call, 4.30 P. M.
Troops go below, 9.30 P. M.
Taps, 10 P. M.

DECK SPACE FOR TROOPS.

On promenade deck, from fore part of deck house to bow, and from after part of deck house to stern, also starboard side of saloon deck and after square, also in fore square as far as troops' quarters.

No smoking allowed in compartments. Troops not allowed. under any circumstances, in crews' quarters.

Hospital will be supplied for troops in the forward and after squares, and a dispensary and surgery on starboard side of after square.

An examination of the accompanying plans will show the general disposition of the ships' spaces available for troops.

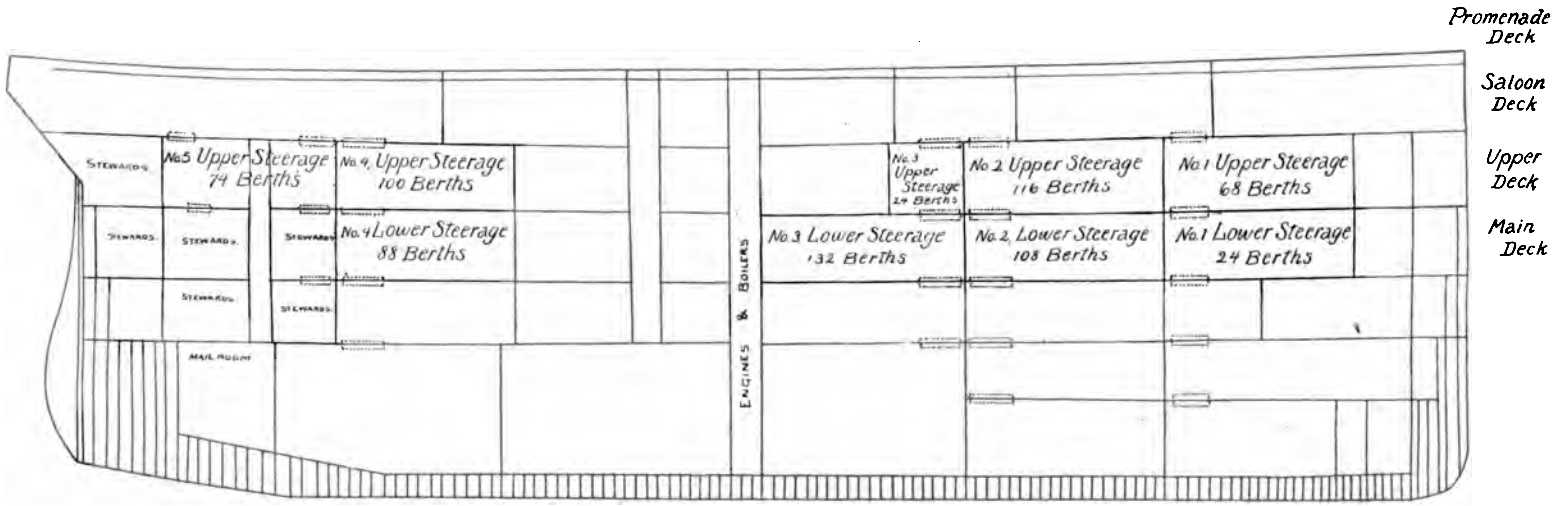
The bulkheads and bunk fittings were removed from the steerages (compartments or sections) on account of the high temperature expected and of the better ventilation which their absence would secure.

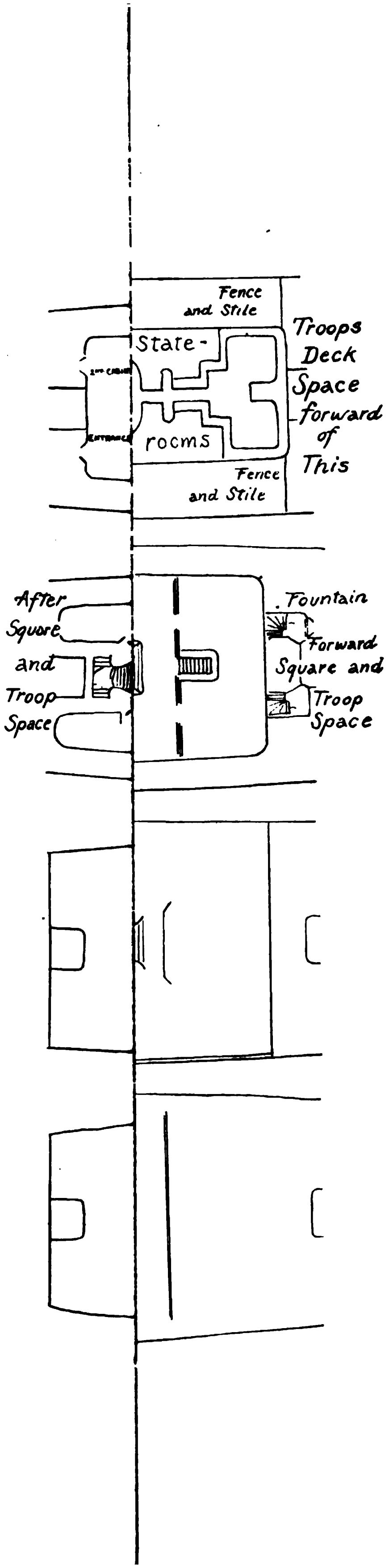
(*a*). The rifles and accoutrements were stowed in one corner of the second saloon (converted into a ration room) instead of in stewards' quarters as contemplated.

(*b*). The serving out of rations was arranged in expectation that the food would be cooked. As the military authorities decided that the men should have cold meals, a detail of men from each company formed in the port passage way, and passing through the end of the ration room from port to starboard, received the cans of meat, vegetables and biscuits and took them to the troops' quarters for division. This operation was quickly performed in an orderly manner.

On my undertaking to prepare hot coffee for the soldiers, a similar disposition was made, except that all the men attended in person, each man coming from port to starboard by the ration room door would dip up a pot full of coffee already sweetened and pass on. Thus each got his proper ration.

(*c*). The weather grew so warm after crossing the Gulf Stream that the troops were allowed to sleep on deck but always in that part alloted to them.


Promenade Deck
Saloon Deck
Upper Deck
Main Deck
STEWARDS.
No.5 Upper Steerage 74 Berths
No.4 Upper Steerage 100 Berths
No.3 Upper Steerage 24 Berths
No.2 Upper Steerage 116 Berths
No.1 Upper Steerage 68 Berths
STEWARDS.
STEWARDS.
STEWARDS.
No.4 Lower Steerage 88 Berths
No.3 Lower Steerage 132 Berths
No.2 Lower Steerage 108 Berths
No.1 Lower Steerage 24 Berths
STEWARDS.
STEWARDS.
MAIL ROOM
ENGINES & BOILERS


Fence and Stile
State-
rooms
2nd CABIN
ENTRANCE
Fence and Stile
Troops Deck Space forward of This
After Square and Troop Space
Fountain
Forward Square and Troop Space

(*d*). Inasmuch as but one regiment embarked, the company letters sufficed.

(*e*). At every limit of the troops' space large white sign boards, about four feet long and proportionately broad, were displayed, bearing legends in black like this : *Troops not allowed forward of this*, or *Troops not allowed above this*, etc. Marine sentries were posted at these points to enforce the order. Much wandering in forbidden places was avoided by these unmistakable directions.

(*f*). The spaces under the forward and after ends of the promenade deck, called squares, corresponding to those under poop and forecastle, were largely given over to the troops.

On the deck in the steerages and squares billets were marked out and numbered, 802 in all. Had the troops been kept down to this figure every man would have had his own sleeping place, but as 1300 came, crowding in proportion was unavoidable.

The officer were assigned first-class cabin rooms on the upper deck, so-called —that immediately below the main saloon. Not more than two were in any room and the seniors very generally had a room each.

The promenade deck rooms were already occupied by the officers attached to the ship and by other naval officers on board for passage.

The army officers messed in the saloon, their seating being fixed by Major-General Brooke. They paid the same mess bill which had been exacted of the Naval Cadets who had gone to Santiago in the transports which conveyed General Shafter's Fifth Corps. The bill of fare was practically that which passengers of the first-class enjoy in going to Southampton in steamers of the American Line.

It was very important to get all the baggage, stores, ammunition and provisions on board and in place before a single soldier was admitted. Yet this obvious precaution demanded my unremitting vigilance, and caused me, I fear, to be unkindly regarded by some who wished to arrive and to settle down. The only exception to the rule was forced upon me by the arrival, late one evening, of a sick officer and his attendant surgeon.

The articles of luggage needed for the trip, having been so marked in advance, were placed in the cabins of their owners, the heavy stores, etc., put in the hold, while the provisions for the voyage and the ammunition sufficient for the first landing were taken into the ration room. When all this was done, the ship was ready for the troops.

They came down to Hampton Roads from Newport News on large railroad flats which made fast alongside. The troops fell in by companies on the flats, marched up the gangway, through the ration room, where they deposited their arms and accoutrements, then proceeded to their sections (under guidance of sailors from the ship), where they remained until the last man was in his place on board. Then the bugle sounded and they were free to roam about within their prescribed bounds. In one hour and fifty minutes the 1300 men were embarked and ready for the voyage without confusion of any kind. The weather being hot, the waiting below was extremely irksome but it was essential to good order and discipline ; otherwise the deck would have been encumbered by a crowd of people.

To the spaces shown on the plans the troops were rigidly confined. Not a man was permitted outside – especially were none allowed on the shade or uppermost deck of all where the boats were carried.

Every day the officers were requested to temporarily vacate one side of the promenade deck that a company of soldiers might be exercised without arms

—more for the purpose of maintaining discipline than of perfecting their drills.

Besides the Third Regiment of Illinois Infantry, the *St. Louis* took from Hampton Roads to Arroyo, Porto Rico, Major-General Brooke and his staff. I count it a privilege to have had the company of so excellent a soldier and so charming a man on this unusual trip. His penetrating insight into the necessity for the rules formulated and his sympathetic aid in maintaining discipline and promoting harmony will not soon be forgotten. I mnst say that co-operation with the Army was rendered by him an unalloyed pleasure.

A careful inspection of the troops' quarters was made at 10.30 A. M. daily by me, accompanied by the Chief Officer, the Purser, the Surgeon, the Chief Steward and, of course, by Lieutenant-Commander Patch. On at least one of these occasions General Brooke was good enough to accompany me.

It was not easy to make the volunteer soldiers take as good care of their sections as could have been wished, for some sea-sickness joined to natural indifference to thwart our intentions, but, in the main, I think they deserve credit. Possibly regulars under regular officers would have done somewhat better than volunteers on board the *St Louis* even if they did less well elsewhere. There were no cases of disorder on the passage.

The officers lived on the promenade deck between the troops' limits, when not at meals or in their bunks. The majority were extremely appreciative of the efforts made by all attached to the *St. Louis* to render them comfortable. Some there were, as might have been expected, who, through ignorance, regarded the captain as responsible for the high temperature which prevails in the tropics, for the disorder of their cabins which were attended to by their own servants, or for lack of the many saloon and deck stewards who swarm on board a trans-Atlantic grey-hound. With three square meals a day of fresh food well cooked, with all the luxuries which could possibly be produced on board an auxuiliary cruiser, and vastly more than could have been expected, with ample deck room for lounging and smoking, a scrupulously clean ship and comfortable cabins, as cool as the best ventilating plant afloat could render them, their lot was enviable in every respect.

The troops came on board in Hampton Roads on July 28th and were landed at Arroyo, Porto Rico, on August 2d and 3d. The subjoined letter from Major-General Brooke shows the manner in which the preparations and rules worked in actual practice.

Headquarters Fisrt Army Corps,
Arroyo, Porto Rico, August 3, 1899.

Captain C. F. Goodrich, U. S. Navy, *U. S. S. St. Louis.*

Captain :—I cannot refrain from expressing to you my gratification at the complete and comfortable arrangements which were made on board your ship for the transportation of my Headquarters and the Third Illinois Infantry from Fortress Monroe to this point. The uniform courtesy and consideration shown by yourself and officers will always be a pleasant remembrance of this time of war.

Trusting that all your future may be as bright and pleasant as your eminent qualities deserve, I am,

Very truly yours,
(Signed) John R. Brooke, Major-General.

—*Proceecings of the U. S. Naval Institute*, March 1899.

The Japanese Armored Cruiser "Asama."

We illustrate the twin-screw cruiser *Asama*, recently built by Messrs. Armstrong, Whitworth & Co. to the order of the Japanese Government, from the designs of Mr. Philip Watts, the head of the Elswick shipyard. She is 408 feet long and 67 feet wide. With her powerful armament, strong defensive armor, and high speed, the vessel forms a most important addition to that formidable navy which is growing up so quickly in the Far East; a navy which is not only strong in its number of vessels, but also in the high efficiency of the separate ships, the professional attainments of the officers, and the seamanlike character of the crews.

This cruiser has no less than 2100 tons of armor worked into her construction. She has a belt of Harveyed steel which extends 2 feet above and 5 feet below the normal water line, and tapers from 7 inches in the thickest part to 3½ inches at the ends. Above this the sides are protected by 5-inch armor which extends over the whole of the midship part and joins the armored bulkheads that connect with the main gun positions. The latter are protected vertically by 8-inch Harveyed steel plates, with an additional inner skin 1-inch thick, there being a 1-inch roof. There are ten casemates of 6-inch Harveyed steel. To protect the bow torpedo discharge there is on each side 6-inch plating, which extends from the stem 25 feet aft. The armored deck is 2 inches thick and is curved in an athwartship direction to join the lower edges of the belt. There is a 2-inch steel plate worked forward to support the lower part of the ram bow, the armored deck extending forward to strengthen the upper part in the usual way. There is an armored conning-tower forward and an armored observation-tower aft. The armament consists of four 8-inch quick-firing guns mounted in pairs in the armored positions referred to forward and aft, as shown in our illustration. The forward guns are 25 feet above the water level, and the after pair 1 foot lower. There are fourteen 6-inch quick-firing guns, ten of which are placed in the 6-inch steel casemates before referred to. On each side of the ship two are placed at each end of the armored citadel, one above the other, as is shown in the engraving. This accounts for eight of the 6-inch guns, the remaining two of the ten in casemates being placed on either side of the ship on the main deck. The other four of the fourteen 6-inch guns are on the upper deck and are protected by shields. The lighter armament consists of twelve 12-pounders and various other weapons of lighter nature. There are five torpedo tubes for 18-inch torpedoes. One of these is through the stem, and is protected as stated, whilst the other four are under water discharges.

The machinery for the *Asama* has been supplied by Messrs. Humphrys, Tennant & Co., and is generally of the usual type, there being two sets of inverted direct-acting engines and cylindrical boilers, pressed to 150 pounds to the square inch. The legend power is 13,000 indicated horsepower with natural draught and 18,000 with forced draught, while the corresponding speeds are 20 knots and 21¼ knots. The normal coal capacity is 700 tons, and with this weight on board the draught is 24 feet 8 inches; but there is storage for 1450 tons if all bunkers are filled.

The *Asama* has more than exceeded the contract conditions, running for six hours with open stokeholds when the horse-power was somewhat above the 13,000 and the revolutions 140 to 142 per minute, at which the speed registered was 20.37 knots. On the forced-draught trials 19,000 indicated horse-power was reached, the revolutions averaging 158 per minute and the speed being

22.07 knots. The gunnery trials and anchor trials have also been successfully carried out.

—*Engineering*, March 3, 1899.

MISCELLANEOUS.

A Healthy Regiment, and the Reason it was so.

By **FRANCIS R. PACKARD**, Philadelphia, Pa., 1st Lieutenant and Assistant Surgeon 2nd Pennsylvania Volunteer Infantry.

As there have been so many accusations and recriminations bandied back and forth throughout the past few months, and so much in the newspapers about unhealthy camps and the sickly condition of the men in them, I have thought it might be of interest to write a few lines concerning a regiment which seems to have possessed the singular good fortune of having passed a really healthful summer and one by which the physical condition of its members was benefitted instead of impaired. This happy organization was the Second Pennsylvania Volunteer Infantry, of which Colonel John Biddle Porter, of Philadelphia, is the commanding officer. The regiment responded under the first call for volunteers and was mobilized at Mt. Gretna, Pennsylvania, in April, arriving at the camp in a cold snow and rain storm. It remained at Mt. Gretna until the 18th of May, when one battalion was sent to Pompton Lakes, N. J., under command of Lieutenant-Colonel Dechert, to guard the Lafland-Rand powder works of that place. A few days after its arrival, dowever, the command was ordered to Penn's Grove, N. J., to guard the Dupont Powder Works at Carney's Point, and throughout the summer stayed at that station being united with the other battalion at Montchanin, Delaware, on the 6th of September.

The battalion which was left at Mt. Gretna was sent on the 19th of May to Montchanin, Delaware, to guard the Dupont Powder Works located there and it remained on that duty until September 15th, when the entire command returned to Philadelphia under orders to be mustered out. Colonel Porter stayed with this battalion.

The surgeon (with the rank of Major) of the regiment was Dr. Herman Burgin, of Germantown, Pa., who had served in the National Guard of Pennsylvania for sixteen years and possessed great experience in all matters relating to camp sanitation and the care of bodies of men in camp. There were two Assistant Surgeons with the rank of First Lieutenant: Dr. Robert P. Robins, who was stationed at Penn's Grove, and the writer, who was at Montchanin. Dr. Burgin remained at the latter place. While at Mt. Gretna the regiment had a strength of seventy-five men to a company, but by the middle of June it had been recruited to ten companies of 106 men each.

Before proceeding further I would premise by stating that throughout the Regiment's stay in camp there was but one death, that of a sergeant, who did not come to the hospital at Penn's Grove until two days before his death, and was then delirious and in a practically moribund condition with typhoid fever. He had been absent in Philadelphia for some time previous to his illness. There was no other case of typhoid fever in the regiment, nor was there a single other case of really serious illness of any kind. The absence of typhoid fever is rendered more remarkable by the fact that in the little village of Rising Sun about one mile from the camp at Montchanin there was an epidemic of typhoid fever in which there occurred eighteen cases and two deaths

THE JAPANESE ARMORED CRUISER "ASAMA".

in a period of about four weeks. It was to this village that the men were in the habit of resorting for their amusement when off duty as it contained the nearest saloons and was the most considerable settlement in the immediate neighborhood. As to the reasons for such an excellent health record I would submit the following:

In the first place the number of men encamped at one place after our departure from Mt. Gretna at no time exceeded 530 exclusive of officers, until September 6th, when the two battalions were joined at Montchanin and remained together until the return to Philadelphia of the entire regiment on September 15th.

Second, the location of the camp at Montchanin, was on a hill in a place free from trees and on a dry shaly soil which became sandy at the depth of a few feet. The Pennsgrove camp was on the sand of river embankment in a grove of trees. The sandy nature of the soil prevented the dampness which might have resulted from the trees.

Third, bathing facilities were excellent for both camps, the Brandywine near the Montchanin encampment, the Delaware river at Penn's Grove, and the men availed themselves of their privileges in this direction to the fullest degree.

Fourth, the food furnished the men was the regular government ration. It was of excellent quality and ample in amount. It was regularly subjected to a rigid inspection whenever an issue of fresh beef, vegetables, etc., was made. The commissary exchanged the flour issued by the government for bread baked at one of the best bakeries in Wilmington. The bacon in the latter part of the summer partook somewhat of the "sow belly," but at no time was uneatable. The men made a great deal of what we are told was a frequent source of complaint throughout the civil war, namely that the coffee issued them was adulterated with saltpetre by the government for the purpose of allaying their animal spirits so as to render the task of keeping them within bounds less difficult. Of course this was farcical. I do not think it ever occurred to the mind of any one save an enlisted man to attribute such properties to saltpetre and I am sure there was no adulteration of the coffee in our camp with it.

Fifth, the sanitary arrangements of both camps were practically perfect. The sinks at Montchanin were built after an orginal design of Major Burgin's, as follows: a hole was dug twenty feet long, eight feet deep and two feet wide. The cerpenters in the regiment constructed a framework of three by two timbers, which was supported by uprights. This framework was four feet longer and two feet wider than the pit. It was covered by a broad piece of muslin which came to within six inches of the top and within six inches from the ground. A roof of the same material was also placed over the frame. The muslin after being tacked to the woodwork was whitewashed. By means of this simple construction shelter from the elements and decency were provided for. and the framework was so light and durable that as soon as one hole became filled it could readily be lifted over another one, and would, with care last an indefinite time. Every morning it was the duty of one of the hospital corps to sprinkle carbolic acid solution over the three by four timber which served as a seat and wherever else there might have been any soiling of the frame by excreta. He also scattered dry earth and lime over the excreta in the pit. No sink was ever placed within 300 feet of the kitchens or the men's tents.

At Penn's Grove the men's sink was located on the wreck of an old scow which lay some distance off the bank. A framework similar to the one in use at Montchanin was constructed on the timbers of the wreck and the men defecated into the old hulk whence the excreta would be flushed out with every tide. The scow was reached by means of a plank walk. By this ingenious device Dr. Robins effectually overcame the difficulty he had to contend with of making sinks in a sandy soil. The officers' sink he located in a place where the soil was not quite so sandy as it was within the camp, some distance back of headquarter's street.

The policing of the camps was most vigilantly looked after, the commanding officers, Colonel Porter and Lieutenant-Colonel Dechert continually impressing upon the company officers the necessity for absolute cleanliness. No waste paper or other trash was allowed to remain about the camp, it being removed to the waste pile which was at a distance from the tents and on which a fire was kept continually going. At least once a week when practicable a warm sunny day was chosen and every tent was struck, the floors taken up and the surface soil which had lain beneath the tent turned up and exposed to the sun for several hours. This measure served to effectually prevent the development of any dampness or mustiness about the tents.

Rigid inspections of quarters were held at frequent intervals. Every Sunday morning the commanding officer, accompanied by his staff, made the rounds of the camp, entering every tent and carefully going over its contents. The men stood at attention in the company streets during the performance of this function and the least evidence of lack of care in the proper attention to the cleanliness of his tent or accoutrements was at once used to serve as the occasion of a lecture to the guilty man. Saturday morning's company inspections were held and every man's personal equipment was closely scrutinised. The water supply at Montchanin came from an excellent well located about fifty yards from the camp. A guard was kept constantly at this point and no waste of the water allowed and any chance of its pollution carefully guarded against. Towards the end of the summer the well became somewhat low, our water supply was supplemented by piping water from a reservoir in the neighborhood. The water at Penn's Grove was derived from a driven well and was abundant and wholesome throughout the entire season.

Seventh, the utmost care was taken in entries made in the morning sick books, which are brought up at sick call by the first sergeants of the various companies. In these books are entered the names of the men who are sick, and in a column opposite the man's name the surgeon marks of what duty the man is capable. It is customary in most regiments to mark a man who is slightly indisposed as capable of police duty. This means that he is able to aid in the cleaning or "policing" of the camp. These men not only pick up stray paper, etc., about the camp, but are very apt to be given work about the kitchens, cutting potatoes, paring onions, etc. Now during the summer season the vast majority of cases that report at morning sick call have diarrhœa. Under such circumstances there is no doubt that many times men in the first stage of typhoid fever or possibly suffering from a fully developed case of "walking" typhoid are put to work just where they have no business to be—about the kitchens. We made it an invariable rule never to allow men with any bowel disturbance to be about the kitchen, under any pretext.

Eighth. Each of the battalions had a large hospital tent for its sick. These tents were provided with board floors and cots, and were kept always in perfectly clean and neat condition. Too much credit cannot be bestowed upon our two stewards, Simmons and Rothwell, for the care they took of their patients and their zeal in maintaining their hospitals in proper condition. The other men in the hospital corps were all carefully picked, four of them for each battalion and they were, throughout, faithful and zealous in the performance of their duties. There was at no time any difficulty in procuring supplies either directly from the government or else by purchase from druggists, authorized by the surgeon-general.

Ninth. The most conspicuous cause, however, for this cheerful condition of affairs in the regiment's various camps is to be found in the fact that the Colonel, Lieutenant-Colonel and the company officers appreciated in the highest degree the necessity for the most absolute obedience to sanitary rules and regulations, and maintained the greatest degree of cleanliness on the part of the men, both as regarded their persons and equipment. This rendered complaints of the irksomeness of the discipline kept up quite a feature of the early part of our service, but towards the end of the regiment's stay in camp there is no doubt the men had learned to appreciate the absolute necessity of the measures adopted to preserve their health. As regards the character of the enlisted men in the Second P. V. Infantry there was great variety. Many of the younger men were the sons of parents whose station allowed them to afford their sons every luxury. Many of the older members of the regiment had given up profitable situations from patriotic motives, or because they were thrilled by the excitement that was in the air. On the other hand many men were drawn from the vast rank of the unemployed, and yet others were geuine hoboes whose one longing was for an easy birth. Fortunately, of the latter we had but few, and most of them were eliminated by various means before we returned to Philadelphia. With a body of men of such a heterogeneous nature it required great firmness and rigid enforcement of discipline to attain the results which undoubtedly were achieved.

When we arrived at the Philadelphia depot there were three men unable to march to the armory with the regiment. Two of them were suffering from sprained ankles and one had a severe cold. Three men were absent in Philadelphia at the time we left camp. We left no sick behind and of those who returned all were in good physical condition with the exceptioh of those mentioned above.

—Reprint from the *Charlotte Medical Journal*, November, 1898.

BOOK REVIEWS.

The Naval Annual, 1899. Edited by T. A. Brassey. Portsmouth: J. Griffin & Co., 2, The Hard. New York: D. Van Nostrand Co.

This valuable annual appears with some new features, several of them of special interest to the United States, viz.: an account of the United States Navy, by Lieutenant-Commander W. H. Beehler, of the Naval Intelligence Office at Washington; a review of the Spanish-American War, by Colonel Sir George Clarke; an interesting description of the operations of the gunboats during the Nile expedition, and some considerations as to where the British ought tofortify, by anonymous writers.

Part I, a general review of the British Navy, was written by Lord Brassey. Then follows an account of foreign navies and a series of comparative tables. Lieutenant-Commander Beehler's account of the United States Navy occupies over thirty pages, and Colonel Sir George Clarke's review of the Spanish-American War over fifty pages.

The articles on armor and ordnance are of more than ordinary interest, with constant reference to American ships and American improvements and methods. Considerable space is devoted to the wire-guns recently introduced into the British service, as well as the new breech-mechanism of these guns.

The present volume of this reliable publication, as a whole, is more valuable, more generally interesting and better prepared than any of its predecessors. It is the world's standard authority on the subject, and voices the world's interest in the questions discussed in its subject-matter.

J. P. W.

BOOK NOTICES.

New Military Books.

[These books will be fully *reviewed* as space becomes available.]

The Hudson-Kimberly Publishing Co. has now in press, and to be ready for mid-summer delivery, the second edition, revised, of the "Campaign of Konniggratz," with an atlas embracing twelve maps, by Lieutenant-Colonel A. L. Wagner, U. S. A.

Hygiene of the Soldier in the Tropics. Translated from the French by Captain G. W. Read, U. S. A.

Notes on the Supply of an Army During Active Operations. Translated from the French by Captain H. F. Kendall, of the 9th Cavalry, and Lieutenant-Colonel Henry G. Sharpe, U. S. A.

The Art of Supplying Armies iu the Field, as Exemplified during the Civil War. By Lieutenant-Colonel Henry G. Sharpe, U. S. A.

The Automatic Instructor. Adapted for the use of officers in preparing for examination, by Captain G. W. Read, U. S. A.

The Hudson-Kimberly Publishing Co. of Kansas City, Mo., claims now to have the largest list of military books on its catalogue of any publishing house in America.

INDEX TO CURRENT ARTILLERY LITERATURE.

PERIODICALS CITED.

Abbreviations employed in index are added here in brackets.

All the periodicals are preserved in the Artillery School Library, Fort Monroe, Virginia.

ENGLAND.

Aldershot Military Society. *Occasional.*
Aldershot. Copies 6*d each.*

Arms and Explosives. [*Arms and Ex.*] *Monthly.*
Effingham House, Arundel Street, Strand, London, W. C. Per year 7*s.*

Army and Navy Gazette. [*A. and N. Gaz.*] *Weekly.*
3 *York Street, Covent Garden, London. Per year* £1 12*s* 6*d.*

Canadian Military Gazette. [*Can. Gaz.*] *Fortnightly.*
Box 2179 *Montreal, Canada. Per year* $2.00.

The Engineer. [*Eng.*] *Weekly.*
33 *Norfolk Street, Strand, London. Per year* £2 6*d.*

Engineering. [*Eng'ing.*] *Weekly.*
35-36 *Bedford Street, Strand, London, W. C. Per year* £2 6*d.*

Journal of the Royal United Service Institution. [*Jour. R. U.S.I.*] *Monthly.*
22 *Charing Cross, Whitehall, London, S. W. Per year* 24 *s.*

Journal of the United Service Institution of India. [*Jour. U. S. I. India*] *Quarterly.*
Simla, India. Per year $2.50.

Photographic Journal. [*Photo. Jour.*] *Monthly.*
12 *Hanover Square, London.*

Proceedings of the Institution of Civil Engineers. [*Proceedings I. C. E.*]
25 *Great George Street, Westminister, London.*

Proceedings of the Institution of Mechanical Engineers.
[*Proceedings I. M. E.*] 19 *Victoria Street, Westminister, London.*

Proceedings of the Royal Artillery Institution. [*Proceedings R. A. I.*] *Monthly.*
Woolwich, England.

Professional Papers of the Corps of Royal Engineers.
[*Prof. Papers Corps Royal Eng'rs.*]
Chatham, England.

Review of Reviews. [*Rev. of Rev. Austral.*] *Monthly.*
169 *Queen Street, Melbourne, Australia. Per year* 11 s. 6 d.

Transactions of the Canadian Institute. [*Trans. Canadian Inst.*]
58 *Richmond Street, Toronto, Canada.*

Transactions of the Canadian Society of Civil Engineers.
[*Trans. Canadian Soc. C. E.*]
Montreal, Canada.

Transactions of the East of Scotland Tactical Society.
[*Trans. E. of S. Tactical Soc.*]
51 *Hanover Street, Edinburgh, Scotland.*

Transactions of the Institute of Naval Architects.
[*Trans. Inst. Naval Architects.*]
5 *Adelphi Terrace, London, W.C.*

United Service Gazette. [*U. S. Gaz.*] *Weekly.*
10, *Wine Office Court, Fleet Street, London, E. C. Per year £*1 10 *s* 6 *d.*

United Service Magazine. [*United Serv. Mag.*] *Monthly.*
13 *Charing Cross, S. W. London. Per year* 27 *shillings.*

FRANCE.

Le Génie Civil. [*Génie C.*] *Weekly.*
6 *Rue de la Chaussée d'Antin, Paris. Per year* 45 *Fr.*

La Marine Française. [*Marine F.*] *Semi-monthly.*
26 *Rue de Grammont, Paris. Per year* 30 *Fr.*

Mémoires et Compte Rendu des Travaux de la Société des Ingénieurs Civils.
[*Ingénieurs Civils.*] *Monthly.*
10 *Cité Rougemont, Paris. Per year* 36 *Fr.*

Mémorial des Poudres et Salpêtres. [*M. Poudres et S.*] *Quarterly.*
Quai des Grands-Augustins, 55, *Paris. Per year* 12 *Fr.*

Le Monde Militaire. [*Monde.*] *Fortnightly.*
76 *Rue de Seine, Paris. Per year* 6 *Fr.*

Revue d'Artillerie. [*R. Artillerie.*] *Monthly.*
5 *Rue des Beaux-Arts, Paris. Per year* 22 *Fr.*

Revue de Cavalerie. [*R. Cav.*] *Monthly.*
Berger Levrault et Cie, Rue des Beaux-Arts 5, *Paris. Per year* 33 *Fr.*

Revue du Cercle Militaire. [*Cercle.*] *Weekly.*
37 *Rue de Bellechasse, Paris. Per year* 27 *Fr.*

Revue du Génie Militaire. [*Génie M.*] *Monthly.*
8 *Rue Saint-Dominique, Paris. Per year* 27 *Fr.*

Revue d'Infanterie. [*R. Inf.*] *Monthly.*
11 *Place Saint André-des-Arts, Paris. Per year* 25 *Fr.*

Revue Maritime. [*R. Maritime.*] *Monthly.*
L. Baudoin, Rue et Passage Dauphine 30, *Paris. Per year* 56 *Fr.*

Revue Militaire de l'Etranger. [*Etranger.*] *Monthly.*
L. Baudoin, Rue et Passage Dauphine 30, *Paris. Per year* 15 *Fr.*

Revue Militaire Universelle. [*R. Univ.*] *Monthly.*
11 *Place Saint André-des-Arts, Paris. Per year* 25 *Fr.*

Le Yacht—Journal de la Marine. [*Yacht.*] *Weekly.*
55 *Rue de Chateaudun, Paris. Per year* 30 *Fr.*

GERMANY.

Allgemeine Militaer-Zeitung. [*A. M.-Zeitung.*] *Semi-weekly.*
Darmstadt. Per year 24 *M.*

Archiv fuer die Artillerie-und Ingenieur Offiziere. [*Archiv.*] *Monthly.*
Koch Strasse, 68-78, *Berlin, S. W.* 12. *Per year* 12 *M.*

Beiheft zum Militaer-Wochenblatt. [*Beiheft.*]
Koch Strasse, 68, *S. W., Berlin.*

Deutsche Heeres-Zeitung. [*Heeres-Zeit.*] *Semi-weekly.*
Wilhelmstrasse 15, *Berlin. Per year* $6.00.

Internationale Revue. [*Int. Revue.*] *Monthly.*
Blasewitzer Strasse 15, *Dresden. Per quarter* 6 *M.*

Jahrbuecher fuer die deutsche Armee und Marine. [*Jahrbuecher.*] *Monthly.*
Mohren Strasse, 19, *Berlin, W.* 8. *Per year* 32 *M.*

Kriegstechnische Zeitschrift. [*Kriegstech.*] *Ten numbers a year.*
Koch Strasse, 68-71, *Berlin. Per year* 10 *M.*

Kriegswaffen. [*Kriegswaffen.*] *Monthly.*
Rathenow, Germany. Per year $4.50.

Marine Rundschau. [*Mar. Rundschau.*] *Monthly.*
Koch Strasse, 68-70, *Berlin. Per year* 3 *M.*

Militaer-Wochenblatt. [*Wochenblatt.*] *Semi-weekly.*
Koch Strasse, 68, *Berlin, S. W.* 12. *Per Year* 20 *M.*

Militärische Rundschau. [*Mil. Rundschau.*] *Occasional.*
Zuckschwerdt & Co., Leipzig. Per quarter 4.75 *M.*

Stahl und Eisen. [*Stahl u. Eisen.*] *Fortnightly.*
Schadenplatz 14, *Düsseldorf. Per year* $5.00.

Umschau, Die. [*Umschau.*] *Weekly.*
Frankfort a. M. Per year 10 *M.*

AUSTRIA.

Mittheilungen ueber Gegenstaende des Artillerie und Genie-Wesens.
[*Mitth. Art. u. G.*] *Monthly.*
Wien, VI, Getreidemarkt 9. *Per year* 1 *Fl.* 50 *Kr.*

Mittheilungen aus dem Gebiete des Seewesens. [*Seewesens.*] *Monthly.*
Pola. Per year 14 *M.*

Organ der Militaer Wissenchaftlichen Vereine. [*Vereine.*]
Wien I, Stauchgasse No. 4 *Per year*, 8-14 *numbers*, 6 *Fl.*

Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines.
[*Z. Architekten Vereines.*] *Weekly.*
I. Eschenbachgasse, No. 9, *Wien. Per year* 10 *Fl.*

SWITZERLAND AND BELGIUM.

Allgemeine Schweizerische Militaer-Zeitung. [*A.S.M. Zeitung.*] *Weekly.*
Basel, Switzerland. Per year, 8 *Fr.*

La Belgique Militaire. [*Belgique M.*] *Weekly.*
Rue St. Georges 32, *Ixelles, Belgium. Per year* 12.50 *Fr.*

Monatschrift fuer Offiziere Aller Waffen. [*Monatschr.*] *Monthly.*
Frauenfeld, Switzerland. Per year 5 *Fr., plus postage.*

Revue de l'Armée Belge. [*A. Belge.*] *Bi-monthly.*
22 *Rue des Guillemins, Liège, Belgium. Per year* 13 *Fr.*

Revue Militaire Suisse. [*R. M. Suisse.*] *Monthly.*
Escalier-du-Marché, Lausanne, Switzerland. Per year 10 *Fr.*

Schweizerische Zeitschrift fuer Artillerie und Genie. [*S. Zeitschrift.*] *Monthly.*
Frauenfeld, Switzerland. Per year 8 *Fr.* 20 *centimes.*

SPAIN, PORTUGAL AND SOUTH AMERICA.

Boletin del Centro Naval. [*Boletin.*] *Monthly.*
438 *Alsina, Buenos Aires, Argentina Republica. Per year* $11.00.

Circulo Naval,—Revista de Marina. [*Circulo Naval.*] *Monthly.*
Casilla num. 852, *Valparaiso, Chili.*

Memorial de Artilleria. [*M. de Art.*] *Monthly.*
Farmacia, num. 13, *Madrid, Spain. Per year, U. S.*, $3.40.

El Porvenir Militar. [*Porvenir.*] *Weekly.*
258 *Calle Montevideo, Buenos Aires, Argentina. Per year* 10 $ $\frac{m}{n}$.

La Prensa Militar. [*Prensa.*] *Weekly.*
Reconquista 1034, *Buenos Aires, Argentina.*

Revista Cientifico-Militar. [*Cientifico M.*] *Semi-monthly.*
5 *Calle de Cervantes, Barcelona, Spain. Per year* 32 *Fr.*

Revista de Engenheria Militar. [*Engenheria Mil.*] *Monthly.*
27 *Rua Nova do Almada, Lisbon, Portugal. Per year* 1 $ 800 *réis.*

Revista do Exercito e da Armada. [*Exercito.*] *Monthly.*
Largo de S. Domingos No. 11, *Lisbon, Portugal. Per year U. S* $6.00.

Revista General de Marina, [*R. G. de Marina.*] *Monthly.*
56 *Calle de Alcalá, Madrid, Spain. Price U. S.* $4.45.

Revista Maritima Brazileira. [*R. Marit. Brazil.*] *Bi-monthly.*
Rue do Conseheiro Saraiva n. 12, *Rio de Janeiro, Brazil. Per year* $1.575.

Revista Militar. [*R. Mil. Portugal.*] *Semi-monthly.*
262 *Rua da Princeza, Lisbon, Portugal. Per year*, $2.60.

Revista Militar. [*R. Mil. Brasil.*] *Monthly.*
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SERVICE OF THE 10-INCH DISAPPEARING GUNS AT FORT POINT, CAL., DURING THE WAR WITH SPAIN.

BY SEDGWICK PRATT, CAPTAIN THIRD ARTILLERY.

Under the provisions of the following order:

GENERAL ORDERS, No. 6. HEADQUARTERS DEPARTMENT OF CALIFORNIA,
San Francisco, Cal., April 25, 1898.

Colonel M. P. Miller, 3rd Artillery, is hereby placed in command of all artillery troops, guns and defensive works, and in control of all war materials in and about San Francisco Harbor, for purposes of instruction and defense.

Post commanders while exercising their functions in post administration will subordinate all other considerations to meet the demands of Colonel Miller in the important duties assigned him in this order. Officers and detachments may be temporarily taken from post to post by government transportation, at the discretion of Colonel Miller, for necessary instruction without change of station.

It is expected that all officers and government agents charged with functions connected with harbor defense will keep in close touch and hearty co-operation for effective defense at all times. By command of Brigadier General Merriam.

EDWARD FIELD, Major 2d Artillery,
Acting Adjutant General.

Battery E, 3d Artillery, was ordered April 27th to Fort Point and assigned to the care and service of the 10-inch disappearing guns. It arrived April 28th with 2 officers and 45 men and immediately commenced preparing for the duties assigned. The men were quartered in tents and in an Engineer lime-shed directly in rear of and about 100 yards from the emplacements.

The Battery of 10-inch B. L. rifles consisted of two guns on disappearing carriages, model 1896, in emplacements 9 and 10, and three guns on disappearing carriages, model 1894, in emplacements 11, 12 and 13.

Permanent details of one (afterward two) men to each gun were made under the charge of the first duty-sergeant. These men were known as "Gun-cleaners" and the Sergeant as "Armament-Sergeant." Their duties were to keep the guns, implements, emplacements, projectiles, galleries and magazines in thorough order.

Old telegraph poles, stumps, loose stones, the old plotting house, etc., were removed from the parapet, and everything in rear of the guns of no use was also removed. The grass on parapets was cut and removed so as not to obstruct the view, especially from the battery commanders look-out.

Magazines and galleries were all cleaned and cleared.

Powder charges were removed from packing boxes, put in storage cases, marked, and stored in the magazines, front sections on one side thereof and rear sections on the other, with primers attached to each section. Candle-lamps and matches were always in place in their niches in magazine gallery in front of magazine doors.

Magazine doors were numbered and marked with contents of magazine and velocity of powder.

Projectiles were all cleaned, oiled and skidded.

Ten armor-piercing shot and ten common shot were placed on loading platform of each gun, the former on the left, the latter on the right, and were always kept cleaned and oiled, ready for loading.

Armament chests, magneto-firing-boxes, rubber-hose, gunners'-lanterns and matches, gun commander's table, and wrench chests were in places assigned in entrance-galleries near the doors. All cleaning material, oils, cosmic, etc., not in armament chests were in oil-rooms near guns.

Kerosene lamps and matches were in their niches in all galleries and relocator-rooms.

Sponge-tubs filled with water, sponge and rammer-props, and sponges and rammers were kept in their places on loading platforms night and day ready for use at any time. Crane-falls with shot-hooks were also ready night and day, and retraction-ropes kept in oil-rooms near the guns.

Four pairs rubber shoes were always ready outside the magazine doors for men of the magazine details.

All wood coverings to parts of carriages were removed and not allowed to be used, as experience in one instance proved that the men might forget to remove them in a hurried manning of the guns.

All rammer-staves were marked with a brass plate showing the normal distance of the base of the projectile from the face of the breech with a scale of tenths of an inch for one inch on either side of normal mark.

Telescopic sights to all guns were adjusted by Captain Babbitt of the Ordnance Department, so also were the elevation indicators.

The Azimuth circles and index plates were carefully adjusted under the superintendence of Mr. Von Geldern of the Engineer Department, and this was done so exactly that the gun and its carriage was about as true as a theodolite in measuring azimuths.

Keys to magazines were numbered and always in the pocket of the senior officer present.

Each officer and the armament-sergeant had keys to the doors of all galleries and oil-rooms, and a set of these keys for each emplacement was kept on a key-board near the manning-detail-board where the gun-cleaners could obtain them, and when not on the key-board all knew that they were in use and would be found in the door of the entrance gallery. There was never an instance of delay for want of keys even when "to arms" were sounded.

Ranges to all permanent and prominent objects from each gun were painted on boards and permanently hung on flank walls of each emplacement where they could easily be seen and read by the gunner and gun commander.

In order to bring the guns mounted on the 1894 carriages to the loading position by the levers, iron cross-bars were made and put on by the Engineer Department at end of levers so that the men heaving on this bar would all have the greatest leverage and easily and rapidly bring the gun down to position. This was suggested by Captain Hobbs from the same idea used in old-fashioned fire-engines.

COMMUNICATIONS.

One pair of wires, of those put up by the Signal Corps in accordance with recommendation of the Board of Fire Control for San Francisco Harbor, was assigned to the disappearing guns. These wires came in from the pit at Point Lobos, with a leg running to relocator-room No. 1, in Emplacement No. 10, and a leg running to relocator-room No. 2, in Emplacement No. 12, also a leg running to pit C used exclusively for the disappearing guns. In Point Lobos pit, in pit C, in relocator-room No. 2 and relocator No. 1 were telephones of the best make with headreceivers; all on these wires. In case either wire was cut the other could be thrown to earth and the telephone used.

Another independent pair of wires was put up running into some places and having independent telephones. This line was the battery commander's line. The other line was used solely for work in connection with the relocating or plotting board, such as designating target to base-end observers, indicating to them the 30 second time intervals, and receiving from them the angles to target. This last line also had a leg to the fort-commander's station on Telegraph Hill (Old Lewis Range Finder).

A third telephone line ran from emplacement No. 9 to Headquarters Harbor Defenses, to Presidio, to Presidio Wharf, to the guard house in rear of emplacement No. 15, to the power house of the Pneumatic battery, to Mortar Battery No. 1, and to Observers' Quarters at Point Lobos where also the observation tower of the Chamber of Commerce was taken in.

The life-saving station on the coast five miles south of Point Lobos, the one at Fort Scott and the one thirty-five miles north of Point Bonita were in communication with Headquarters Harbor Defenses.

Three men who had served in the Navy were detailed for duty in the watch-tower over the guard-house with orders to report all vessels coming in having the appearance of war vessels. They were in telephonic communications with the disappearing guns and Headquarters Harbor Defenses.

Field pieces were placed at the guard house and it was understood that two guns fired in quick succession was a call "to arms."

The Pneumatic guns were "blown" every week. On one occasion two of them were "blown" in rapid succession. The men, even the cooks and assistants, immediately commenced to run to the guns.

Sentinels were posted on the parapet along the whole line to guard the emplacements and to watch for and report war vessels coming in.

Voice tubes ran from relocator-room No. 1 to emplacements 9, 10 and 11 and to lookout No. 1, and voice tubes from relocator-room No. 2 to emplacements 11, 12 and 13 and lookout No. 2.

The mouth-pieces of tubes at No. 11 from relocator-rooms 1 and 2 were side by side, so that messages from either room could be re-transmitted by the same man and thus permit the five guns to be in communication with either relocating-room.

In each emplacement 9 and 10 voice tubes also ran to the "magazine," "shot gallery" and "next gun."

A pair of firing-lines ran along in rear of the five guns with a leg to each gun and to each relocator-room. This line was put up by Lieutenat McNair, and with one magneto-firing-box would explode primers in the five guns simultaneously.

In the relocator-rooms the voice tubes were arranged side by side so that one man could attend to all of them.

HORIZONTAL BASE AND BASE-ENDS.

A horizontal base was selected extending from point "C" to the point "W" showing on the following sketch.

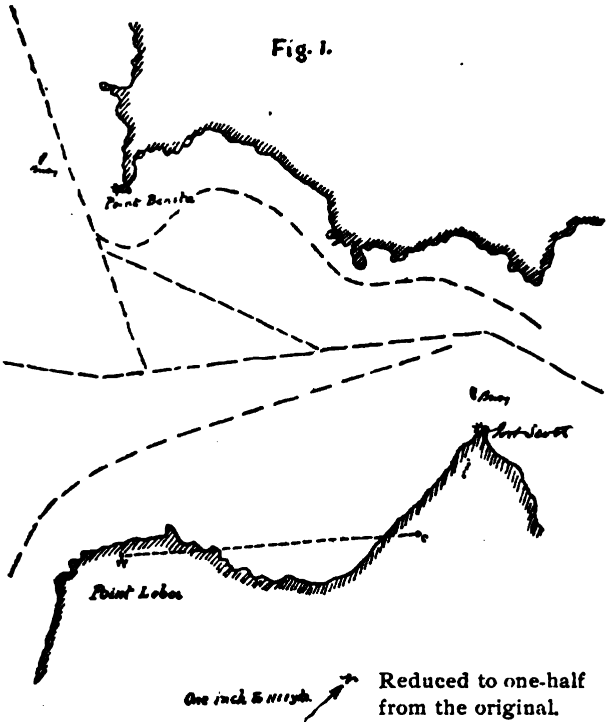

Fig. 1.

Reduced to one-half from the original.

These points are about 300 feet above the sea-level.

Their location and the azimuth and length of base line were determined by Mr. Von Geldern before mentioned. The length was 3499.3 yards. The direction of the line was not what was desired but was the best obtainable. At *C* and *W* pits were dug about 8 x 10 feet to a depth of 6 feet. These were floored, lined with two-inch plank and covered with a shingled pent-roof having a sky-light over the base-end. The pits were drained, and all excavated soil removed out of sight so as not to attract attention. The pit coverings showed about two feet above ground. The pit *C*, 1008 yards from gun No. 11, was the " principal station."

The observers at pit *W* were quartered in a house built for them and were rationed for ten days at a time.

The instrument used at base-end for taking angles was the ordinary azimuth circle.

Point Bonita Light, whose azimuth was known, was used for setting the instruments for taking azimuths.

The following sketch shows the arrangement of things in plotting-room No. 2, the arrangement in room No. 1 being about the same.

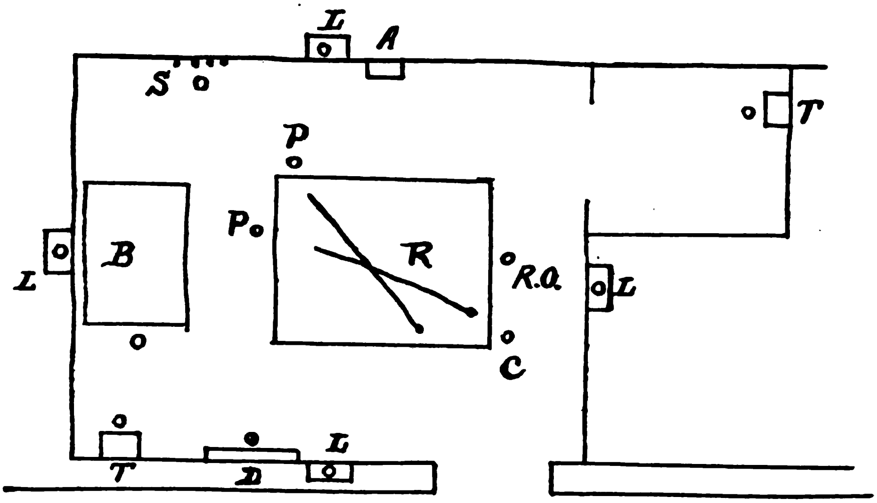

Fig. 2.

A, anemometer bell, the anemometer mounted on heavy pole about 100 yards away to the left on top of a traverse.

B, ballistic board for determing all corrections to elevation and direction in laying or aiming guns. One operator at O.

C, clerk.

D, blackboard, (and operator O, not necessary).

L, L, L, L, kerosene lamps in niches.

P, P, plotters at o o at respective plotting arms.

R.O, range-officer.

S, voice tubes, and operator o.

T, telepone and operator o for line to base-ends.

T, telephone and operator o for battery commander's line.

R, plotting board.

T, thermometer.

The aneroid barometer was in the battery commander's tent.

Including the clerk there were nine persons in the plotting room.

Six or seven men are sufficient.

The anemometer was arranged to ring every tenth of a mile.

Chart. The scale of the chart was 200 yards to the inch.

The chart was not divided into squares. All unnecessary lines and markings were avoided. The average tacks of "dago" boats, tugs, steam-schooners, coast-steamers and sail vessels. and foreign steamers and vessels were drawn on the chart from time to time as determined at tracking drills. These proved of great assistance in predicting positions.

Arcs of circles with the points representing base-ends as centers and with a radius of about three feet were drawn on the chart with great care and graduated to five minutes. Lines two inches apart and parallel to the meridian line were drawn on the chart to aid the range officer in placing the "spanner."

Plotting arms. Two were used, one at each point representing the base-ends. The one pivoted at "C," the principal station, was known as the range-arm. It was made of steel with its left edge beveled and graduated to ten yards, (200 yards to the inch.)

This edge passed through the pivot. The arm from "W" was of brass, about one-sixteenth of an inch thick and had no markings of any kind on it. Its left edge also passed through the pivot. By causing the left edges to pass through the pivots the angle at the intersection of the arms was obtuse and permitted the point of the plotting pencil to be easily and *closely* applied at the vertex.

Method used in plotting. In figure 3, C and W are the base-ends; CR and WW′ are the plotting arms; 9, 10, 11, 12 and 13, the guns; L the Lewis Range Finder; O the target; S the South point and SC a meridian, C‴ C‴ arc for arm WW′, and C′ C′ arc for arm CR; a is the azimuth of target from C and its value read on the arc at R; 13-O is direction of target from gun 13 and 13-S′ is meridian through gun 13; e is the azimuth of target from gun 13.

If through the target a line O-O′ be drawn parellel to the line from gun 13 to principal station C, and O-O′ be made equal to 13-C, and if the arm C be moved to O′, then e′ will equal e and the reading at R′ will be the azimuth of the target from the gun, and the reading of the range scale on this arm at O′ will be the range of the target from gun 13. Thus the arm C and its arc C′ C′ can be used for plotting the target and determerming the azimuth and range of target without the use of an arm pivoted at the gun and an extra arc drawn for it on the chart.

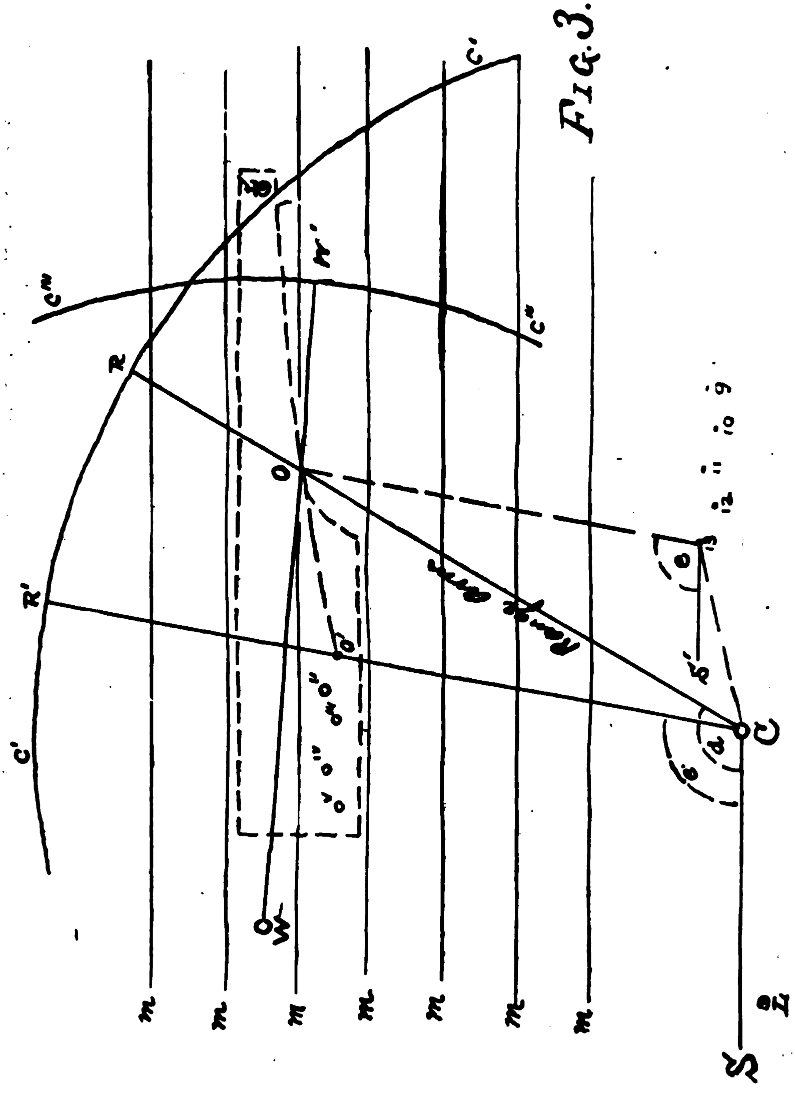

Fig. 3.

Whatever be the position of the target the line O-O′ will always be parallel and equal to 13-C and make the same angle with the meridian through the target as 13-C does with the meridian through 13.

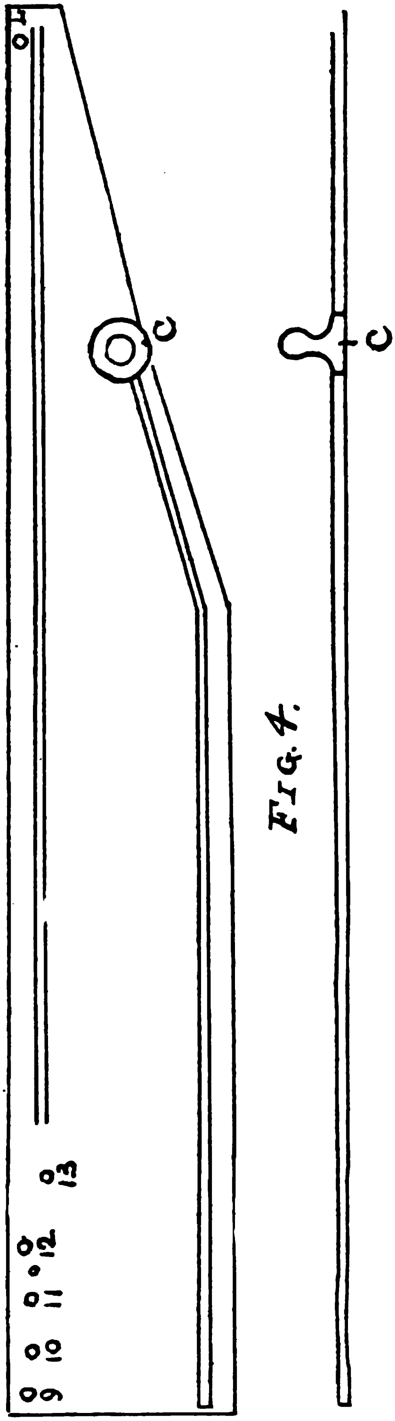

FIG. 4.

If we draw lines from C to each of the other guns and, similarly as above, find the points O^2, O^3, O^4, and O^5, and move the arm C in succession to these points, we can determine the range and azimuth of the target O from each and all of the five guns. And in the same way the point L′ can be determined and the azimuth and range of O from L (or guns to the left of C), and from guns in front or in rear of C.

Now suppose meridian lines two inches apart be drawn on the chart as shown at m m m m m m m. Cut out of sheet zinc or brass a figure in shape and size the same as the dotted figure in Fig. 3, and at L′, O^1, O^2, O^3, O^4 and O^5 drill small holes just large enough to admit a pencil-point. At O fasten a needle point projecting below the plate about one-sixteenth of an inch. This plate will now constitute the "spanner" used with the ten-inch guns. In actual dimensions it is shown in figure 4.

To use it: suppose O to be the target as plotted, and its azimuth and range from guns 9 and 12 required. Stick the needle point of the spanner into the chart at O and turn the spanner about this point until its parallel edges are parallel to a meridian line; with a pencil make a mark through holes 9 and 12; remove the spanner;

bring range arm to the marks in succession and read azimuths and ranges as indicated.

Though the principal station, C, at Fort Point was 1106 yards from No. 9, the results obtained with the spanner used were entirely satisfactory. It is not necessary to locate the positions of the guns on the chart. They can be determined at any time by means of the spanner applied at C.

Predicting and deviation scales. The following will explain these :

Camp at Presidio, Cal., May 21, 1898.

The Adjutant, 3d Artillery.

(Through Battalion Headquarters.)

Sir :

I desire to invite the attention of the Commanding Officer to a device for quickly determing the deflection allowance due to speed of vessel in any direction relative to the line of fire, for the time of flight corresponding to any range.

The 10-inch B. L. rifle is taken for illustration. A speed of ten miles per hour is five yards per second. Multiplying the times of flight for ranges from 2000 to 9000 yards by 5, dividing the products by the number of yards in one "point" for the various ranges, then multiplying the quotients by 3.5 (the number of minutes in one "point") we will have :

Range.	Deflection allowance in minutes.
2000 yards	27.7
3000 "	28.7
4000 "	29.8
5000 "	30.8
6000 "	31.8
7000 "	33
8000 "	34.3
9000 "	35.6

By taking 35 minutes as the deflection allowance for a speed of ten miles per hour for time of flight at all ranges the greatest error will be about 6 yards, and for the 6000 yard range. This error decreases to 0 at range near 9000 yards.

Let the scale shown in figure 5 represent an ordinary "Predicting Scale" with the exception of the red portion, which, however, will form part of the predicting scale.

Since at the rate of ten miles per hour a vessel will pass over 100 yards in 20 seconds, if from O to "a" we lay off half an

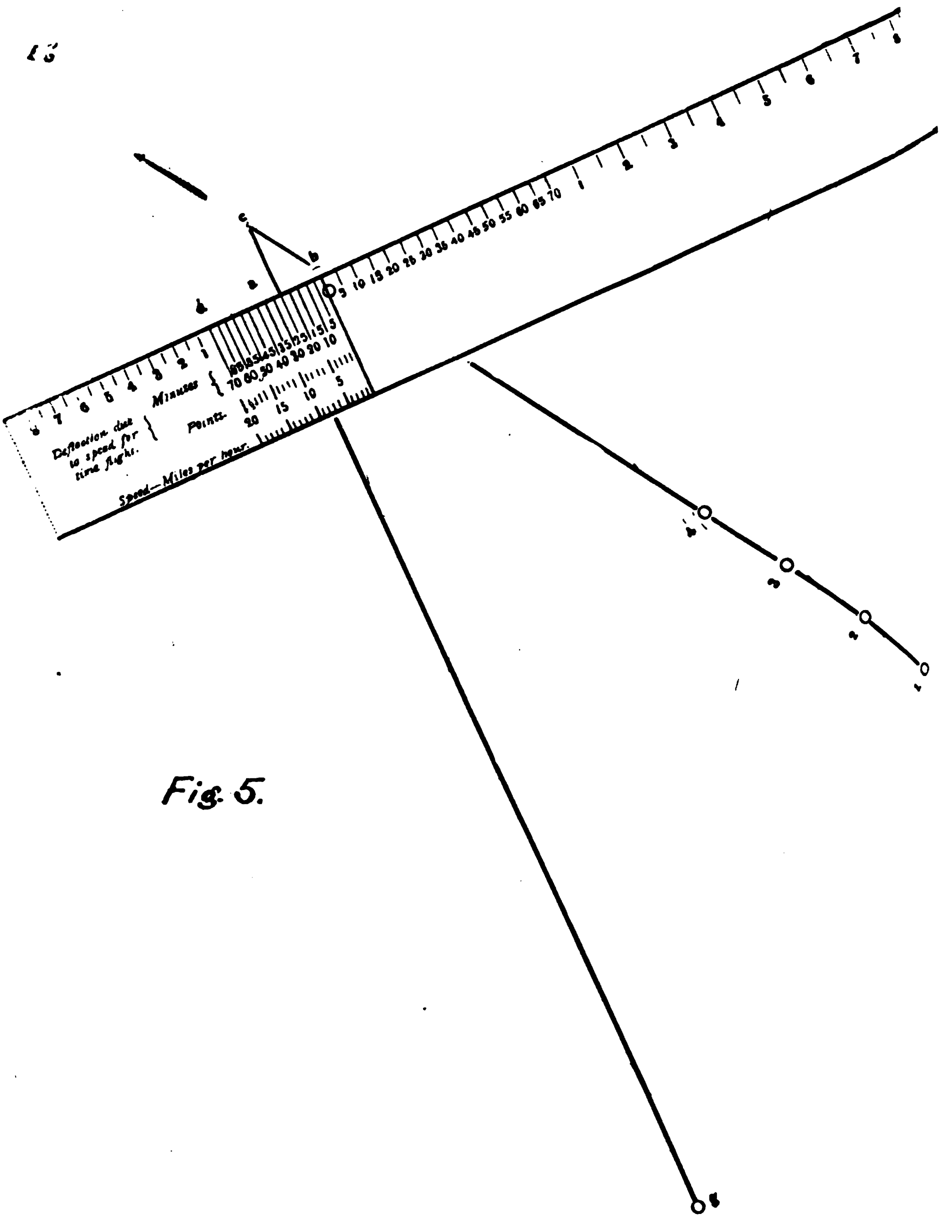

Fig. 5.

The part of the scale along the upper edge numbered 8 to 1 (on left) and 1 to 8 (on right) is correctly printed in *black* ink; the rest should be in *red* ink.

inch it will represent her travel in 20 seconds to the scale of the plotting chart (200 yards to the inch). The interval, 20 seconds, is taken because it is the observing interval in vessel-tracking or position-finding. If we lay off one inch from O we will represent the travel of a ship in 20 seconds moving 20 miles an hour. In this way the scale representing "Miles per Hour" is constructed, and by it the speed of a vessel is obtained as shown later.

Now, since 35 minutes is the deflection at all ranges for corresponding times of flight and for a speed of 100 yards in 20 seconds, it is evident that Oa may represent this, and Oa' the allowance (70 minutes) for a speed of 200 yards in 20 seconds or 20 miles per hour. If, therefore, we divide Oa' into 14 equal parts each part will represent 5 minutes deflection allowance. Figure 5 shows this scale constructed; below this scale is a corresponding scale of "points" deflection.

To use the devise (see figure 5).

Suppose c to be the predicted position as plotted, and b the position 20 seconds prior, found by means of the distance between position 1 and 2, which is laid off on vessel's track backwards from c.

Let g be the plotted position of the gun, and gc the edge of the gun-arm, passing through c for the purpose of getting the predicted range.

Place the predicting scale as shown, with zero at b and the edge of the scale perpendicular to the gun-arm or to the line of fire. Read the scale where the line of fire cuts it. In the example it is 25 minutes, the required deflection allowance. Or it is seven "points."

The speed of the vessel across the line of fire is seven miles an hour and fourteen miles an hour in her own track, as will be seen by applying scale from O to c.

The above principle holds for other guns.

Very respectfully,
(Signed) Sedgwick Pratt,
Captain, 3d Artillery.

Ballistic board. This was a device for determing quickly the corrections in elevation due to weight of shot, change in velocity, wind, temperature and barometer, and the corrections in azimuth due to wind and drift.

It was operated by one man.

Blackboard. This was hung on the wall opposite the voice tubes and marked as follows:

Elevate.	Depress.	Deviation.	Time of flight.
° ′	° ′	R L	

Wind . . . . . . O'clock.
Miles . . . . . .per hour.
Temp. . . . .
Bar. . . . .

The device for determining wind components was with the ballistic board and was operated by the man who operated the latter.

The device for ascertaining the direction of the wind relative to the target consisted of a clock-dial about two inches in diameter pivoted to the pivot of the range-arm of the plotting-board. (See figure 6). The hours of the dial were numbered to the left. The battery commander from his look-out gave the direction of the wind to the plotting-room. The dial was then turned till 12 o'clock pointed on the chart to the point whence came the wind and was clamped so that it would not turn on turning the range-arm.

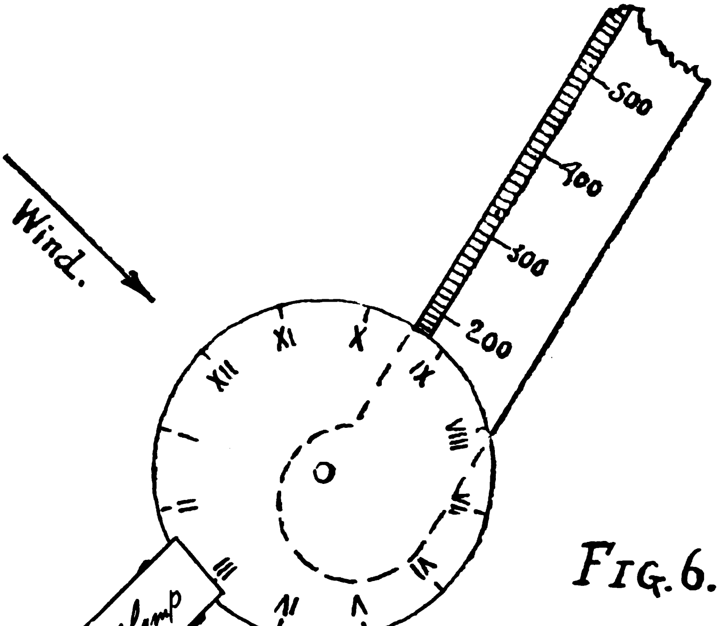

FIG. 6.

As soon as the target was plotted and the range-arm brought to the point so as to get the range and azimuth of the target, the reading of the dial where the graduated edge of the range-arm cut the dial was announced and written on the black-board.

Proportional dividers were kept on the plotting-board and were found useful in predicting and getting speed of vessels.

Strips of burlap about two feet wide were hung from the ceiling of the plotting-room to break up the reverberations caused by the walls when any person was speaking. These strips answered the purpose satisfactorily.

MANNING SERVICE.

Under the law allowing 200 men to a battery the number of men increased rapidly to about 175 men (not including men left at Fort Mason).

These were divided into two reliefs as far as possible, each consisting of five gun-detachments, five ammunition details, and five reserves. There were also two plotting-details, each consisting of one range-officer, two plotters, one ballistic-board operator, two telephone-men, one speaking-tube man, one black-board man and one clerk. Also a speaking-tube man at each gun.

The battery was formed as required in "Drill Regulations for Coast Artillery."

Each man was assigned special duties.

All unnecessary noise and talking at stations was prohibited. Constant attention was given to eliminating unnecessary words in message so as to gain time as much as possible.

Drill at the guns was for two hours in the morning and two hours in the afternoon daily. The battery commander from his lookout station, or from station C, would designate the target to the range-officer in the plotting-room, also the direction of the wind. From the plotting room the designation of target was sent to base-end observers and to the gun commanders. The barometric height given by the battery commander, the wind velocity, and temperature were recorded on the black-board, and the wind-dial on the range-arm set for the wind.

The men being at their posts and the target recognized the range-officer, with stop-watch in hand, would call out "Ready, One, Two, Three," start his watch at "Three" and place it on the plotting-board.

The telephone man with his head-receiver on and his stop-watch in hand would repeat in his telephone these commands and start his watch at "Three" and place it on its shelf on in front of him. In a few seconds he would announce (for instance) "One hundred and four, twenty-five." This meant that the target angle at C was 104° 25′.

The plotter at the range-arm would repeat the angle and set his range-arm to the reading on the arc, call out "Set," and hold the arm in position. Almost immediately after the first announcement the telephone man would announce the angle from W, when the other plotter would set his arm to the reading on his arc and call "Set." Then the range-officer would mark the intersection of the arms, signal the arm to be removed a little and draw a small circle around the mark. Every 30 seconds the telephone man would call out "Ready, One, Two, Three" and announce the angles received, the plotting being performed as before. Three positions having been plotted the arms would be moved aside, the predicting-scale applied by the range-officer and the predicted position of target for end of third minute marked on chart. The "Spanner" was then applied at this point by the range-officer and the targets for guns in action marked. (See figure 3). The range-arm was brought to each target in succession and the range announced. The clerk announced the reading of the wind-dial, which reading was written on the blackboard. The ballistic-board operator, from the range announceed, immediately determined the corrections and announced them in succession, thus: "Elevate 5 minutes," elevate 2 minutes. depress 3 minutes, "5 minutes left," "4 minutes left;" "Time 8 seconds." The blackboard operator would put them on the board thus:

Elevate.	Depress.	Deviation.		Time of flight.
° '	° '	R	L	
5	3		5	8
2			4	
—			—	
7			9	
3				
—				
4				

Wind 9.30 o'clock.
Miles 30 per hour.
Temperature 72.
Barometer 30.8.

The speaking-tube man, with all tubes open and his mouth about a foot from them, would call out, "Range forty-five twenty-five," or "No. 11, range so and so," "No. 12, range so and so" and so on, whatever the range may have been. When no number of gun was sent the range was for all guns. The range-officer having announced the ranges the plotter at the range-arm would call out as the arm was set to the different targets, "Number 11, azimuth one hundred and fourteen, twenty-five," and, when repeated by speaking-tube man, call out similarly the azimuth for the guns in succession, repeated by speaking-tube man as before, who would then look at the black-board and call out in all tubes, "Elevate four minutes," "Nine minutes left."

As soon as the range was received at each gun the gun-commander would cause the elevation for the range (corrected for level of gun) to be given. This corrected elevation was taken from the gun-commander's table which was in a frame under glass and suspended from a hook on the carriage above the elevating wheel. On receiving the elevation correction from the speaking-tube it was readily applied. The gunner, on hearing the azimuth announced caused the carriage to be traversed to the angle, and the correction to be applied on its being received.

A gun being ready the fact was sent to the plotting room, announced and recorded so as to show number of seconds remaining till command "Fire" should be given.

The range-officer would now look at the black-board for time of flight, and at the predicted time less the time of flight would command "Fire," repeated in all tubes and at the guns. At the predicted time (third minute) he would call out "Hit," repeated to all guns. At "Hit" the observers at telescopic sights noted the reading of target on scale in the sight and send it to the plotting-room for record.

These men had nothing whatever to do with laying the guns.

During all this time the angles would be coming in every thirty seconds and plotted.

When for any reason a gun should not be fired the order "Hold fire" would be sent to that gun which would hold its fire and come in on next salvo with new conditions.

Vessels and boats of all kinds were practiced upon; some for 12000 yards.

Range-officers were frequently changed, non-commissioned officers acting as such. They were also changed on same vessel.

Plotting-boards (in rooms 1 and 2) were operated for one or more guns, for all guns, and this together or independently. Plotters and others were occasionally changed.

Drills to test telephone and speaking-tube men at the five guns at once were held, each man recording the data sent and received which were afterwards compared and errors noted.

A daily record was kept on a blank prepared for the purpose.

The results for the day were reduced to the regulation target, a battle-ship broadside to or end on.

100 per cent. of hits broadside to and 45 per cent. end on were frequently obtained. Anything less than 80 per cent. and 25 per cent. respectively was considered only as *fair*.

The data for the five guns at same predicted target was obtained and sent to the guns in two minutes allowing one minute for laying. If the loading was not completed in time, fire would be held, the loading completed and the laying effected for the next salvo. With brown powder, which requires water to be used after each round, it is not believed that guns could be fired oftener than every six minutes.

Thirty seconds was found to be a better observing interval than twenty seconds.

Frequently the command " Relocator out of action " would be given from the lookout station. This would be sent to base-end observers and to the guns. Angles would then cease to come in. The gunner of the directing gun would estimate the range, speed of vessel across the line of fire, and the direction of wind relative to the target. These data were sent to the range-officer, who sent to the guns the corresponding corrections in elevation and direction. The gunner of each gun at his telescopic-sight gave the command " Fire " at the proper time.

This firing would continue till " Relocator in action " was received when predicted firing would be resumed.

Changing target took three minutes.

" To arms " was occasionally sounded.

Time was taken in one instance with the following result. From the signal " To arms " (the men in quarters and not anticipating the signal) to getting range was five minutes, and to firing the two guns manned each scoring a " hit, " was 5 minutes and 45 seconds. This time interval included preparing the guns for action, opening the magazines and lighting the lamps, designating the target, notifying the base-ends, taking, receiving and plotting angles, predicting, ascertaining corrections, loading and laying the guns.

The following copies of " Predicting Drill Record " were selected from the daily records as representing some of the best work of different range-officers and parties, different plotting-boards and so forth.

The observing interval was always 30 seconds and the predicting interval 3 minutes, but the successive predictions were not necessarily 3 minutes apart, for the reason that the range-officer freqently for good reasons, would allow several observations to be plotted before commencing his prediction.

For this reason the differences of successive ranges are not for differences of successive time of 3 minutes, but are always for a predicting interval of 3 minutes.

For this reason also the number of observations given on records numbers 3 and 4 do not agree, though they are for the same target by different plotting boards.

As before stated, the base-line was about 300 feet above the sea-level. The usefulness of a second base-line near the sea-level became apparent by experience. Fog would often obscure the view of the sea from a station at any height; at other times it would shut out the sea from the 300 feet altitude, while at a station lower down the sea would be visible; again, at other times, though the *sea* would be shut out from the high altitude, yet from this altitude mast-heads of vessels and steamers could be seen over the fog bank.

Designating the target *by description* often consumed much valuable time, especially if there were several vessels in the same neighborhood. Designating by means of the Type B Range Finder was very unsatisfactory on account of the error in range, notwithstanding the fact that the vertical base was over 200 feet and corrections made for tide.

This range-finder was provided with a permanent base or pillar, near gun number ten, built by the Engineer Department. A tide schedule for every half hour was prepared for the day by the battery officer.

In designating target by this instrument the azimuths and range of target were taken with it three times, at intervals of 30 seconds, and sent to the plotting-boards, where the positions were plotted, the predicted position for end of third minute determined and azimuth at C and W (base-ends) telephoned to the observers at these stations, who knew that the target should appear in their telescopes at the signal given at the end of third minute.

Relocator No. 2.
Range Officer, Sergt. Caston.
Interval 30 seconds.

PREDICTING DRILL RECORD—(I).

Battery E.

Date, July 20, 1899.
Predicting Time, 3 min.

Began Interval.	Range.	Time from "Ready" to "Hit."					Result from Gun.										Plotting Board.		Position Finder.	Remarks.
		No.	No.	No.	No. 12	No. 13	No.		No.		No. 12		No. 13		No.					
							L	R	L	R	L	R	L	R	L	R	L	R		
	2390				seconds						F H		F H							Fishing boat.
	2200					13					M		M							
	2190										O			12′						
	2110										O			24						
	9130										F H 9′		F H 12							Schooner 4.3 miles per hour.
	8380										F H		F H							
	8120											15		18						
	7635										M		M							
	7335				20	20						21		12						
	6955											3		9						
	6595				22	20						12		12						
	6340					10					B		B							
	5840				20	20					M		M							
	5420				20	15					21		12							
	4980				20	20					9		6							
	4420										M		M							
	4030				20	20						57		60						
	3835					10					9		3							
	3370				12	10					15		15							
	2970				10						9		6							
	2550										48		45							
	2200				12	10					M		S							
	1860										30		M							
	1500				20	15					O F		45							
	4020				20						B		B							Full rigged ship.
	3775				25	20					B		B							
	3400					25					B		B							
	3140										S			12						
	2770										18		15							
	2480					15					22		16							
	2430				15	15					17		5							
	2010					10					O F		O F							
	1800					15					M		B							
	1710				7	15					M		M							
	1645					24					O		M							

93 per cent. of hits broadside. 58 per cent. end on. Indirect laying. M = midship. B = bow. F H = fire held. O F = out of field of telescope. O = obstruction.

Relocator No. 1.
Range Officer, Sergt. Stultz.
Interval, 30 seconds.

PREDICTING DRILL RECORD—(2).

Battery E.

Date, August 5, 1899.
Predicting Time, 30 min.

Began Interval.	Range.	Time from "Ready" to "Hit."					Result from Gun.										Plotting Board.		Position Finder.	Remarks.
A. M.		No.	No. 11	No. 9	No. 10	No.	No. 11 L	R	No. L	R	No. 9 L	R	No. L	R	No. 10 L	R	L	R		
				seconds							minutes									
9.15	3950							21′												Pilot boat.
	3690		35				4′													
	3490		85					56												
	3265		45					20												
	3000		35					30												
	2740			5			3′								30′					M = midship.
	2420		5	45	15		3				15				27					S = stern.
	2215		45	35	40		31				39				10					B = bow.
	2000		42	22	32			13			S				M					
	1775		55	37	45		31				48				70					
	1570		40	29	42		12				48				65					
	1450			20	40		S				18				5					
	1100				8		B				M				M					
	1100			17	35		M				3				M					
9.50	9600			50	12		11				12				27					Pilot boat.
	9200		55	40	47		5				3				18					
	8990			38	48		1								15					
	8780			25	30		4				3				18					
	8520		51	35	50		4				6				21					
	8285		50	35	45		9				9				27					
	8110		42	45	48		4				6				21					
	8000		45	30	45		1				M				15					
	7680		56	45	50		5				3				24					
	7470		44	33	30		30				6				30					
	7250		55	30	40		11				9				24					
	6990		44	36	46		12				12				30					
	6750		45	50	50		4				6				21					
	6535		65	52	56		5				3				18					
	6385		48	29	40							24			M					
	6010		48	45	45							6			6					
	5740											9			3					

96 per cent. broadside. 46 per cent. end on. Indirect laying. No. 10 telescopic sight not in adjustment.

PREDICTING DRILL RECORD—(3).

Relocator No. 2.
Range Officer, Capt. Pratt.
Interval 30 seconds.

Battery E.

Date, August 11, 1899.
Predicting Time, 3 min.

Began Interval.	Range.	Time from "Ready" to "Hit."					Result from Gun.										Plotting Board.		Position Finder.	Remarks.
P. M.		No.	No.	No. 13	No.	No.	No.		No.		No. 13		No.		No.					
							L′	R	L	R	L	R	L	R	L	R	L	R		
				seconds							minutes lost									
1.08	7630																			Square rigged ship. 3.5 miles per hour.
	7460										3′									
	6830			5							4									
	6620			7							19									
	6330			30								9′								
	6000			3								5								
	5730			3							4									
	5400			15								18								
	5170			15								18								
	4920			10							16									
	4680										1									
	4370			8								5								F H = fire held.
	4090										F H									
	3800			30								3								
	3530			30								1								
	3300			30								1								
	2820			30							6									
	2550			15								4								
	2260											2								
	2000										15									
	1780											12								
	1580										lost									
	1410			15							1									
	1200										F H									

100 per cent. = broadside. 75 per cent. = end on. Indirect laying.

Relocator No. 1.
Range Officer, Sergt. Stultz.
Interval, 30 seconds.

PREDICTING DRILL RECORD—(4).

Battery E.

Date, August 11, 1899.
Predicting Time, 3 min.

Began Interval. P. M.	Range.	Time from " Ready " to " Hit."					Result from Gun.										Plotting Board.		Position Finder.	Remarks.
		No.	No. 9	No. 10	No.	No.	No. L.	R.	No. 9 L.	R.	No. L.	R.	No. 10 L.	R.	No. L	R.	L.	R.		
			seconds						minutes				minutes							
1.15	7265								12											Full rigged ship. 3.5 miles per hour.
	7000		45						18											
	6952		5						15											
	6740		42						18											
	6520		32							2										
	6320		35						M											M = midship or zero deviation.
	6110		44						M											
	5930		40						5											
	5760		5	10					2				7							
	5595									1				2						
	5430								6				7							
	5040		12	8					21				11							
	4840		27	32					11					2						
	4670		7	22						2			5							
	4505		33	35					1				1							
	4315		35	30					1				6							
	4110								3				9							
	3920								16				25							
	3745								29				32							
	3545									2			M							
	3380		20	20					2				11							
	3285		10	5						13			9							
	3010		30	33						6			9							
	2835		15	18				15					21							
	2660		45	30				2					12							
	2470		10	15					1				24							
	2285		24	34				5					20							
	2110		9	9				39					45							
	1910		17	7				3					wrong azimuth							
	1760		16	2					18					31						
	1600		24	14				12					12							
	1465							2					13							
2.25	1280		20	32					vessel out of sight											

100 per cent. broadside. 56 per cent. end on. Indirect laying.

Relocator No. 2.
Range Officer. Capt. Pratt and Lt. Butner.
Interval 20 seconds.

PREDICTING DRILL RECORD—(5).

Battery E.

Date, August 12, 1899.
Predicting Time, 3 min.

Began Interval. P. M.	Range.	Time from "Ready" to "Hit."					Result from Gun.										Plotting Board.		Position Finder.	Remarks.
		No.	No.	No. 13	No.	No.	No.		No.		No. 13		No.		No.					
							L	R	L	R	L	R	L	R	L	R	L	R		
				seconds								minutes								
9.02	8000			15					Capt. Pratt.			9							10 short	Schooner.
	7320											13							45 short	Dago boat.
	7110			10								21							10 over	
	6700											F H							30 short	
	6170			16								wrong azimuth								
	5930																			
	5670											16								
	5150											F H								
	4820											10								F H = fire held.
	4600								Leiutenant Butner.		24									M = midship or zero deviation.
	4425											3								
	4300			35								13								
	4125			30								12								
	3920										M	M								
	3695			13								6								
	3455			15								32								
	3275			40							16									
	3000			30								7								
	2700										31									
	2455											2								
	2210			12								19								
	1970			10								1								
	1695										M									
	1435			40							15									
	1000			22							60									
	800										36									

100 per cent. = broadside. 41 per cent. = end on. Indirect laying.

Range Officer, Lieut. Butner.
Interval, 30 sec.

Battery E.

Predicting Time, 3 min.

Began Interval.	Range.	Time from "Ready" to "Hit."					Result from Gun.										Plotting Board.		Position Finder.	Remarks.
P.		No.	No.	No.	No.	No.	No.		No.		No. 13		No.		No.					
							L.	R.	L.	R.	L.	R.	L.	.	L.	R.	L.	R		
											minutes									
1.15	3900											39								Steamer 8 miles per hour.
	4490											17								
	5000										2									
	5520											14								
	6090										1									
	6645											11								
	7180											23								
	7850											29								
	8310										11									
	8830											23								
	9420										9									
1.45	6920											14								Schooner 4½ miles per hour.
	6375											1								
	5940										4									
	5575										4									
	5045											13								
	4630											14								
	4415											31								
	4130											8								
2.00	7150											1								Four-masted schooner 3½ miles per hour. M = Midship or zero deviation. F. H. = Fire held.
	6575										6									
	6065											3								
	5590											18								
	5070											12								
	4520										M									
	4035										3									
	3610											18								
	3350										6									
	3150											18								
	2990										M									
	2840											3								
	2745										3									
	2675										M									
	2570										FH									
	2440										9									
	2400											6								
	2300										15									
	2170										42									
	2035										3									
	1845										M									
	1685											21								
	1515										3									
	1300										30									

95 per cent. broadside. 52 per cent. end on. Indirect laying.

RECORD OF ACTUAL FIRING.

Relocator No. 2. *Object, test of carriage.*
Range Officer, Lieut. Butner, Battery E, 3d Artillery. *August 24, 1898.*

No. of Gun.	Target, a point at sea.		Correction in Azimuth.	Correction in Elevation.	Result.				Remarks.
	Azimuth.	Range.			Over.	Short.	Right.	Left.	
					yds.	yds.	minutes.		
9	93° 36′	4610 yds.	− 5′	+11′	180		6.0		Charge 275 lbs. B. P. Powder. Short (C. I.) 575 lbs. Wind XI o'c. 34 m. h. Temp. 62° V supposed to be 2025 f. s., but probably was 2085 f. s. Altitude of gun, 200 ft.
11	94° 50′	4610 "	−11′	+11′ 10′= +1′	130		0	0	
12	95° 50′	4630 "	−11′	+11′ −22′= −11′		10		6.6	
				Correction for altitude of gun not included in these allowances.					

NEW BALLISTIC TABLE FOR DIRECT FIRE.

According to the experiments of Bashforth, the quadratic law of resistance holds for all velocities between 1330 f. s. and 2800 f. s.; and therefore when both the initial and terminal velocities of a projectile lie within these limits the method for solving problems in curved fire given in the January–February number of the *Journal* is also applicable to direct fire. We give herewith a table of the most important ballistic functions for direct fire, computed for a velocity of 3000 f. s., by means of which all the formulas contained in the paper above referred to become equally applicable to the problems of direct fire, within the specified velocity limits, by simply changing 800 to 3000 wherever this number occurs.

As is well known, Bashforth experimented with projectiles (now obsolete) having ogival heads of 1½ calibers radius, while most modern projectiles have longer heads of 2 calibers radius, which move through the air with less resistance than the older projectiles. A theoretical investigation published in the *Journal* for April, 1895, page 191, showed that ballistic tables based upon Bashforth's experimental data could be used for modern projectiles by making

$$c = 0.914$$

c being the so-called *coefficient of reduction* (or of form).

Siacci has recently published a ballistic table based upon Bashforth's experiments, supplemented by those made by Mayevski at St. Petersburg in 1869. In the introduction to this table he states that by making

$$c = 0.896$$

his resistance formula represents the experiments made by Hojel and also the Krupp firings at Meppen.* This value of the coefficient of reduction differs but slightly from the theoretical coefficient of 0.914. It has been found by actual trial that, with Bashforth's data, if we make

$$c = 0.9$$

the computed and observed ranges for our seacoast guns agree very well for medium ranges.

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* *Rivista d'Artiglieria e Genio*, 1896, Vol. IV. Also *Journal*, November-December, 1897.

We may employ the quadratic law of resistance for our high-power guns for the ranges and angles of departure given in the following table :

GUN.	Log C. ($c = 0.9.$)	Muzzle Velocity.	Range.	Angle of Departure.
8-inch	0.71670	2200 f. s.	6700 yds.	5° 36′
10-inch	0.80543	2200 "	8300 "	6 10
12-inch	0.88740	2200 "	10000 "	8 21
16-inch	1.01227	2200 "	13300 "	11 16
4.7-inch	0.30451	2600 "	3500 "	2 19

We will add a few examples :

Example 1. An 8-inch rifle fired at Sandy Hook with a charge of 85 pounds of Laflin & Rand's smokeless powder gave to a projectile weighing 301 pounds a muzzle velocity of 2267 f. s. What would be the angle of departure necessary for a horizontal range of 3000 yards? Also, what would be the striking velocity, time of flight, angle of fall and maximum ordinate?

We have $d = 8\text{-in.}$, $w = 301$ lbs. and $c = 0.9$; whence

$$\log C = 0.71815$$

The arithmetical operations may be arranged as follows :

$\log X = 3.95424$
$\log C = 9.71815$
———
$\log z = 3.23609$
$z = 1722.2$

Next, from the table, we take

$u = 2349$
$A = .00730$
$T' = 0.651$

$\log B' = 0.07072$
$A'' = 467$

$\log u = 3.37088$
$\log V = 3.35545$
$c \log 3000 = 6.52288$
———
$\log v = 3.24921$
$v = 1775$ f. s.

$2 \log 3000 = 6.95424$
$\log A = 7.86332$
$\log C = 0.71815$
$c \log V^2 = 3.28910$
———
$\log \sin 2\varphi = 8.82481$
$2\varphi = 3° 49' 50''$
$\varphi = 1° 54' 55''$
———
$\log \tan \varphi = 8.52427$
$\log B' = 0.07072$
———
$\text{long} \tan \omega = 8.59499$
$\omega = 2° 15'$
———
$\log C = 0.71815$
$\log T' = 9.81358$
$\log 3000/V = 0.12167$
———
$\log T = 0.65340$
$T = 4.5$ sec.

$$\begin{aligned}
\log A'' &= 2.66932\\
\log C &= 0.71815\\
\log \tan \varphi &= 8.52427\\
\hline
\log y_0 &= 1.91174\\
y_0 &= 81.61 \text{ ft.}
\end{aligned}$$

Example 2. What must be the muzzle velocity and angle of projection in Example 1 for a maximum ordinate of 100 feet?

Solution: Since the maximum ordinates, for the same range and projectile, are proportional to the tangents of the angles of projection, and the sines of twice the angles of projection are inversely as the squares of the corresponding muzzle velocities,* we have

$$\tan \varphi = \frac{100}{81.61} \tan 1^\circ\ 54'\ 55'' = \tan 2^\circ\ 20'\ 47''$$

and

$$V = 2267 \left(\frac{\sin\ 3^\circ\ 49'\ 50''}{\sin\ 4^\circ\ 41'\ 34''}\right)^{\frac{1}{2}} = 2048.5 \text{ f. s.}$$

Example 3. What would be the striking energy of the projectile of Example 1, and how many inches of Harveyized steel armor would it penetrate with normal impact?

Solution: The general expression for the energy of a projectile moving with a velocity v is

$$E = \frac{w\,v^2}{2\,g}$$

If in this expression we take the foot as the unit for g and for v and the pound for w, we shall have for the striking energy of the projectile in foot-tons

$$E = \frac{w\,v^2}{2 \times 2240 \times 32.16} = [4.84141 - 10]\,w\,v^2 \qquad (1)$$

For the penetration of Harveyized steel plates, in inches, we will employ the following expression based upon the firings at Indian Head, and which represents them fairly well:

$$\tau^{\frac{3}{2}} = [8.72883 - 10]\,\frac{E}{d^{1.8}} \qquad (2)$$

The numerical calculations may be arranged as follows:

$$\begin{aligned}
\text{Const. } \log &= 4.84141\\
\log w &= 2.47857\\
2 \log v &= 6.49842\\
\hline
\log E &= 3.81840 \quad \therefore\ E = 6583 \text{ foot-tons.}
\end{aligned}$$

---

* See *Journal* for January-February, 1898, pages 63 and 65.

$$\begin{aligned} \text{Const. log} &= 8.72883 \\ c \log d^{1.3} &= 8.82598 \\ \hline & 3)1.37321 \\ & .45774 \\ \hline \log \tau &= 0.91547 \quad \therefore \tau = 8.23 \text{ inches.} \end{aligned}$$

Example 4. The 16-inch B. L. R. now in process of construction by the Ordnance Department is expected to fire a projectile of the modern type weighing 2370 pounds, with a muzzle velocity of 2000 f. s. At what range will this projectile penetrate 18 inches of Harveyized steel armor, striking normally?

Solution : From equations (1) and (2) we obtain

$$v^2 = [5.15859] \frac{E}{w} \tag{3}$$

and

$$E = [1.27117]\, d^{1.3}\, \tau^{\frac{3}{2}} \tag{4}$$

$$\begin{aligned} \text{Const. log} &= 1.27117 \\ 1.3 \log d &= 1.56535 \\ \tfrac{3}{2} \log \tau &= 1.88291 \\ \hline \log E &= 4.71943 \quad \therefore E = 52412 \text{ f. t.} \\ \text{Const. log} &= 5.15859 \\ c \log w &= 6.62525 \\ \hline & 2)6.50327 \\ \hline \log v &= 3.25163 \quad \therefore v = 1785 \text{ f. s.} \end{aligned}$$

For this projectile, therefore, to pierce 18 inches of Harveyized steel plates normally would require an energy of 52412 foot-tons and a striking velocity of 1785 f. s. We now know C, V and v, and to find X and φ we employ Prob. 20.* We have

$$u = \frac{3 \times 1785}{2} = 2677.5$$

$$z = 800 + \frac{50}{38} = 801.3$$

$$A = .00309 + .013 \times .00042 = .003095$$

$$\begin{aligned} \log z &= 2.90380 \\ \log C &= 1.01227 \\ \hline \log X &= 3.91607 \\ X &= 8243 \text{ ft.} = 2748 \text{ yds.} \end{aligned}$$

---

* *Journal* for January-February, 1899, page 29.

$$\begin{aligned}\log A &= 7.49066\\ \log C &= 1.01227\\ \log 2.25 &= 0.35218\\ \hline \log\sin 2\varphi &= 8.85511\\ 2\varphi &= 4^\circ\ 6'\ 28''\\ \varphi &= 2^\circ\ 3'\ 14''\end{aligned}$$

Example 5. According to the *Scientific American* of February 11, 1899, the proposed 12-inch navy gun is to fire a projectile weighing 850 pounds, with a muzzle velocity of 3000 f. s. Make the the same calculations for this gun as those made for the 16-inch army gun in Example 4. For this projectile we have

$$\log C = 0.81681$$

$$\begin{aligned}\text{Const. }\log &= 1.27117\\ 1.3\log d &= 1.40294\\ \tfrac{3}{8}\log\tau &= 1.88291\\ \hline \log E &= 4.55702 \quad \therefore E = 36060 \text{ f. t.}\\ \text{Const. }\log &= 5.15859\\ c\log w &= 7.07058\\ \hline &2)6.78619\\ \hline \log v &= 3.39309 \quad \therefore v = 2472.2 \text{ f. s.}\end{aligned}$$

Since in this case $3000/V = 1$, we have

$$\begin{aligned}u &= 2472.2\\ z &= 1362.3\\ A &= .00558\\ \log z &= 3.13427\\ \log C &= 0.81681\\ \hline \log X &= 3.95108\\ X &= 8935 \text{ ft.} = 2978 \text{ yds.}\end{aligned}$$

$$\begin{aligned}\log A &= 7.74663\\ \log C &= 0.81681\\ \hline \log\sin 2\varphi &= 8.56344\\ 2\varphi &= 2^\circ\ 34'\ 50''\\ \varphi &= 1^\circ\ 17'\ 25''\end{aligned}$$

The navy gun will therefore pierce 18 inches of Harveyized steel plates at a little greater distance than the army gun, and with a much flatter trajectory.

Example 6. What is the constant ratio of the striking velocities of the projectiles of Examples 4 and 5 for the same normal penetration of Harveyized steel?

Solution: Distinguishing symbols relating to the two guns by the initial subscript letters *a* and *n*, we have, by equating the two expressions for penetration,

$$v_n = \left(\frac{d_n}{d_a}\right)^{0.65} \times \left(\frac{w_a}{w_n}\right)^{\frac{1}{2}} v_a$$

$$= \left(\frac{12}{16}\right)^{0.65} \times \left(\frac{237}{85}\right)^{\frac{1}{2}} v_a$$

$$= [0.14145]\, v_a = 1.385\, v_a$$

That is, for the same penetration of Harveyized plates the striking velocity of the navy projectile must be 1.385 times that of the army projectile, whatever the penetration may be.

Example 7. At what range would the penetration of Harveyized steel plates be the same for the army and navy guns of the preceding examples?

Solution: Let C_a and C_n be the respective ballistic coefficients of the two projectiles, and put

$$m = \frac{C_a}{C_n}$$

Then, for the quadratic law of resistance, it may easily be shown that when the range is the same for two similar projectiles we have the following relation between their respective muzzle and striking velocities, namely:

$$\frac{V_n}{v_n} = \left(\frac{V_a}{v_a}\right)^m$$

But we also have the relation, by Example 6, when the penetration of Harveyized steel plates is the same,

$$v_n = [0.14145]\ v_a$$

Whence we have, in this case, by a slight reduction,

$$v_n^{m-1} = [0.14145]\ \frac{V_a^m}{V_n}$$

For the two projectiles in question we have

$$m = \frac{w_a}{w_n}\left(\frac{d_n}{d_a}\right)^2 = \frac{2370}{850} \cdot \frac{144}{256} = \frac{2133}{1360}$$

and

$$m - 1 = \frac{773}{1360}$$

Also, $V_a = 2000$ and $V_n = 3000$. Applying these numbers we have

$$\log v_a = \frac{1360}{773}\left\{ 0.14145 + \frac{2133}{1360} \times 3.30103 - 3.47712 \right\}$$

$$\therefore \log v_a = 3.24009 \text{ and } v_a = 1738.2 \text{ f. s.}$$

$$\therefore \log v_n = 3.38154 \text{ and } v_n = 2407.4 \text{ f. s.}$$

With either of these values of v we find

$$X = 3386 \text{ yds.}$$

and

$$\tau = 17.373 \text{ inches.}$$

For a range of 3386 yards therefore the normal penetration of the naval and army guns is the same. For a range less than 3386 yards the penetrating power of the navy gun is greater than that of the army gun ; but beyond this range the army gun is the more powerful, that is, if we agree to measure the power of the guns by the thickness of Harveyized steel plates they can penetrate.

At the muzzle of these guns we should have the following values :

GUN.	Energy.	Penetration of Wrought Iron.	Penetration of Harveyized Steel Plates.
16-inch	65800 f. t.	37.8 inches.	20.95 inches.
12 "	53097 "	39.8 "	23.30 "

The muzzle energy of the army gun is 24 per cent. greater than that of the navy gun, while its penetration of wrought-iron is 5 per cent. less and of Harveyized steel plates 10 per cent. less than that of the navy gun. But the real power of a gun is not measured by what it might do at the muzzle, but what it can do at the target. It is a much fairer comparison of the power of two guns whose ballistic coefficients differ considerably to compare their penetration of ship's armor at one or more standard fighting ranges—say at 1500, 2500 and 3500 yards.

Example 8: The high-power navy gun will probably have a muzzle velocity of 2750 f. s. instead ot the higher velocity given by the *Scientific American*. The projectile is to be 3 calibers long and will weigh 850 pounds. By increasing its length to 3½ calibers the projectile would weigh 1000 pounds, which is the weight of our army 12-inch projectile. This projectile could have a velocity of about 2550 f. s. without increasing the strain upon the gun. Compare the penetration of the two projectiles at 1500, 2500 and 3000 yards.

For the 1000-pound projectile we have

$$\log C = 0.88739$$

Employing the methods of Example 3, the following are easily obtained. It will be seen that the heavier projectile is superior to the lighter, and that this superiority increases rapidly with the range.

GUN.	Energy at 1500 yds.	Energy at 2500 yds.	Energy at 3500 yds.	Penetration at 1500 yds.	Penetration at 2500 yds.	Penetration at 3500 yds.
Navy 12″ . . .	36704	32235	28317	18.21	16.70	15.32
Army 12″ . .	38255	34240	30668	18.72	17.39	16.16

JAMES M. INGALLS,
Major of Artillery.

D	T'	D	log C'	D
			—10	
411	0.034	34	4.5574	41
411	0.068	34	4.5615	41
412	0.102	35	4.5656	42
411	0.137	36	4.5698	42
411	0.173	36	4.5740	42
411	0.209	36	4.5782	42
411	0.245	37	4.5824	42
411	0.282	38	4.5866	43
411	0.320	38	4.5909	43
411	0.358	39	4.5952	43
410	0.397	39	4.5995	43
410	0.436	40	4.6038	44
410	0.476	40	4.6082	44
410	0.516	41	4.6126	44
409	0.557	42	4.6170	44
409	0.599	42	4.6214	44
409	0.641	43	4.6258	45
409	0.684	43	4.6303	45
409	0.727	44	4.6348	45
408	0.771	45	4.6393	45
408	0.816	45	4.6438	46
408	0.861	46	4.6484	46
407	0.907	46	4.6530	46
407	0.953	47	4.6576	46
407	1.000	48	4.6622	46
406	1.048	49	4.6668	47
406	1.097	49	4.6715	47
405	1.146	50	4.6762	47
405	1.196	51	4.6809	47
405	1.247	52	4.6856	47
404	1.299	52	4.6903	48
403	1.351	53	4.6951	48
403	1.404	54	4.6999	48

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AN AUTOMATIC SIGHT WITH A MAXIMUM AND MINIMUM HEIGHT CAM.

BY MAJOR H. C. DUNLOP, R. A., Woolwich.

GENERAL DESCRIPTION.

Fig. 1 shows the essential principles of a sight without mechanical detail. $A\ B$ is a bar carrying tangent and fore-sight, or, better, a telescope with cross-wires. It is pivotted at B, a point on the mounting, or on the gun near the trunnions. It carries a sliding collar S, and it is graduated from h to H for heights of the gun above sea level. PP' is a lever carrying the cam. It is pivotted at P, a point on the mounting. G is a stud in the gun. T is a strong hanging tangent scale; K a clamp for it on the gun. The various pivots may be anywhere, provided they are arranged so that both S and G have a good travel along the curved surfaces of the cam when the gun is elevated or depressed. The sight is actuated by the motion of the gun. When the latter is elevated the stud G on the gun bears on the cam and causes it to drop, and, as the sight-bar bears on the cam, the line of sight is raised.

With the above conditions it is required to cut a cam that shall give the proper angles of elevation to the gun at all heights of tide.

CUTTING A CAM.

Referring to Fig. 2, let $A\ B$ represent the sight-bar, $G\ O$ the gun, H the point of the sliding collar when it is set at H, h its point when it is set at h. Let G be the stud on the gun. Let $R_0\ R_1\ R_2\ R_3$, etc., represent the positions of A above the horizontal through B for successive ranges, and for a maximum height of battery H.

Let $r_0\ r_1\ r_2\ r_3$, etc., represent the same, but for a minimum height h. Let $a_0\ a_1\ a_2\ a_3$, represent the angles of tangent elevation corresponding to the ranges R_0 or r_0, R_1 or r_1, R_2 or r_2., etc. Then to trace the curve of the cam:

1. Clamp $A\ B$ and $O\ G$ to a_0. Set $A\ B$ to R_0. Revolve the cam lever till the uncut cam plate covers H and G. From H mark C; from G mark D.

2. Make the point C travel along $h\ H$ from H to h by revolving $B\ A$ and $P\ P^1$. The point G will crace the curve $D\ D^1$. Cut this portion of the cam. This is then the point blank portion of the cam for all heights.

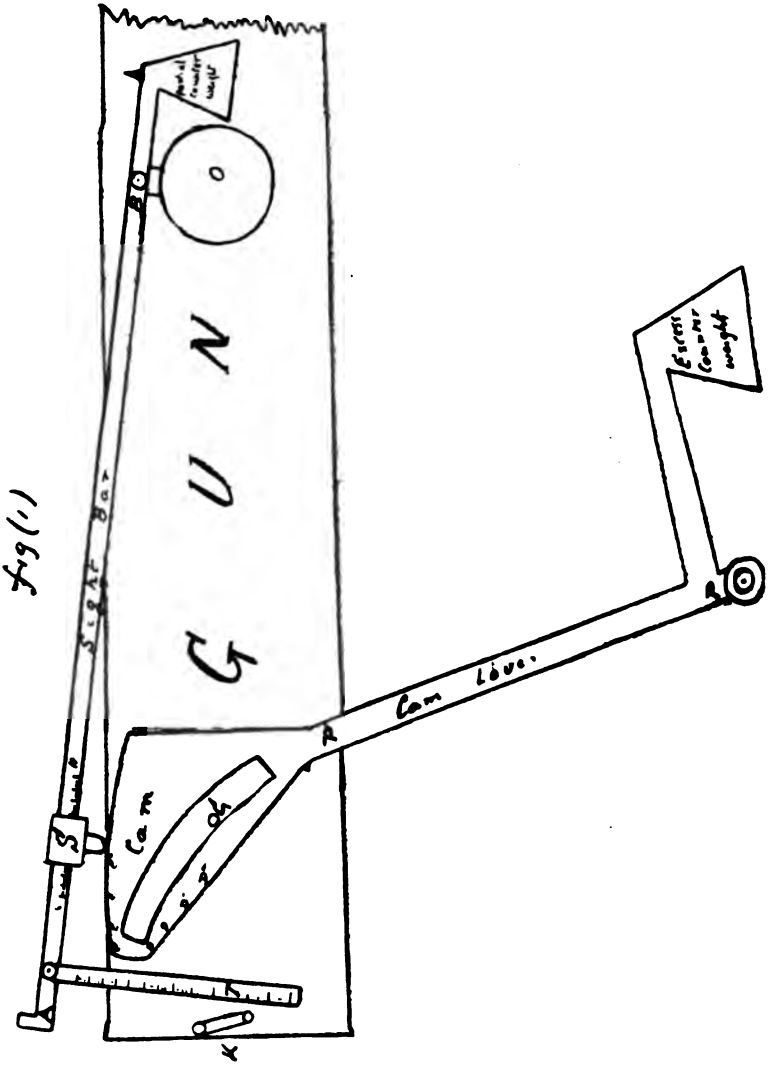

Fig (1)

3. Unclamp $A\ B$ and $O\ G$. Set $A\ B$ and $O\ G$ for R_1 and a_1 and make the curve $D\ D^1$ touch G. The point H will fix a point on the curve $C\ C^1$. Repeat for R_2 and a_2, for R_3 and a_3. Cut the portion $C\ C^1$ of the cam, which together with the portion $D\ D^1$ gives the elevation s from R_1 to R_2 for the maximum height H.

4. Set $A\ B$ and $O\ G$ for r_1 and a_1, r_2 and a_2, etc. For each setting, make the curve $C\ C^1$ touch h. The point G will trace the curve $D^1\ D^{11}$. Cut this portion of the cam; together with the portion $C\ C^1$ it will give the elevation for r_1, r_2, etc., for the minimum height.

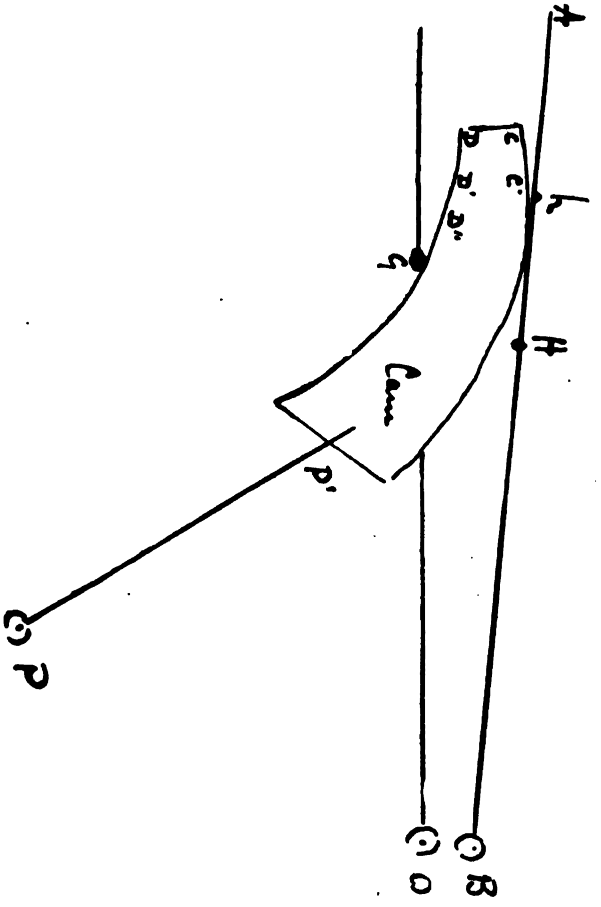

Fig (ii)

5. And so on alternately as in 3 and 4.

Graduation of the height scale. — The hight scale $h\ H$ is graduated by trial and error for intermediate heights.

Compensation for drift.—A lateral cam bearing against the stud G and bolted to the vertical cam gives compensation for drift or lateral deviation.

General advantages.— Besides being accurate for all ranges and heights, the method described of cutting a cam permits of the various pivots being placed almost anywhere, so the sight need not interfere with essential gun gear. There need be no hinges. Y-s do quite as well and the sight can then be lifted off and put in store when not required for use. There is no backlash. Any tendency to that is overcome by gravity and no springs are required.

To understand the description, paper models of tangent scale gun and sight-bar should be pivoted on a drawing board. A sheet of tracing paper also pivoted on the board may be substituted for the uncut cam plate and the cam curves can then be easily traced.

A sight with accessories such as are indicated in fig. 1 permits of the following operations:

Measuring height of battery.

A. To set the sight for height of battery, given a datum point at the water level to which the horizontal distance is known.

(1) Clamp the tangent scale to the datum distance.
(2) Lay on the datum point.
(3) Move the sliding collar along till the cam is touching it and *G*.

Measuring powder error.

B. To adjust before practice for error due to weather and small changes of muzzle velocity.

(1) Clamp the tangent scale at a long range.
(2) Lay on any clear water space by making the cam touch *S* and *G*.
(3) Fire.
(4) Relay as above during the time of flight. Then unclamp the tangent scale.
(5). Taking care not to move the gun, move the sliding collar till the line of sight comes on to the splash.
(6) Repeat from (1) to (5) for a second round, clamping the tangent scale to the same long range, but moving the sliding collar one half only of the way towards the splash; for the 3rd round, one-third; for the 4th, one-fourth. This method is not exact, but the error is very small.

Automatic corrections as well as automatic laying.

C. To correct during firing without any calculations, supposing the observation of one's own shots possible.

(1) Lay on the waterline.
(2) Fire.
(3) Relay on the waterline during the time of flight, and, if the ship is moving, keep "on" till the shot strikes.

Then

(4) Taking care not to move the gun, move the sliding collar *n* towards the splash, where *n* is the number of rounds during which the conditions remained approximately unaltered. Thus for instance a sudden change in the speed or direction of the ship would bring *n* back to unity.

This method is not exact, but it suffices; for, when shooting, the source of error is not known. The error may be caused by powder, weather, racers, speed of ship, etc., etc.

Raising the trajectory.

D. To fire at a ship's tops.

(1) Lay on the waterline.
(2) Clamp the tangent scale.
(3) Lay on the point desired and fire.
(4) Repeat all three, first unclamping the tangent scale.

THE BICYCLE FOR WAR PURPOSES.

By Captain B. F. S. BADEN-POWELL, Scots Guards.

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PART I.

ITS USES IN WAR—AT HOME—ABROAD—TACTICAL AND STRATEGICAL—AS A MEANS OF TRANSPORTING TROOPS—SCOUTING—ORDERLY—AS MOUNTED INFANTRY—TRANSPORT—CONVEYANCE OF WOUNDED—SPECIAL—ROADS.

To begin with, I think it would be superfluous on my part to dilate on the advantages of the employment of bicycles in war. They may be briefly summarized by saying that such machines enable the soldier to be rapidly transported from place to place at a speed about three times greater than the ordinary marching and without utilizing the expensive, forage-consuming, noisy, and comparatively delicate horse. The subject has been exhaustively treated of by Colonel Savile (in a lecture before this Institution in 1888) and by Colonel Balfour (in a chapter on "Employment of Cyclist Infantry" in Gall's *Tactics*).

But since these articles were written great changes have been made in the construction of cycles, and the whole subject has been more carefully considered. Thanks to our Volunteers, much practical experience has been gained, and it now seems probable that we shall shortly actually introduce the bicycle as a regular and recognized addition to a modern army. As regards foreign armies, an excellent account of what has been done has been compiled by Lieutenant Whitney, of the U. S. Army, in the *Journal of the Military Service Institution.* At home we are about to take a defininite step in this matter by the systematic training at Aldershot of sections of Regular troops. One subaltern, one sergeant, one corporal, and twenty-five men from each battalion will be taken in turns and trained under the supervision of Colonel Alderson, the officer commanding the mounted infantry. Altogether five companies are to be trained, the course lasting six weeks. Just at present, too, the cycle construction seems to be narrowing down to one groove. Only a few years ago there were many different patterns of machine, but now that we have had experience of them all it seems that the time has come to decide on the exact pattern of machine most suitable for military purposes.

Considering the popularity of cycling, it seems curious that more has not recently been written on the subject of its adaptation for war, and as no one else more competent than myself seems inclined to bring it forward I have collected the notes for the following paper in hopes they may be of use and interest.

I had intended to confine my remarks to the details of construction only, but before that can be gone into at length it will be necessary to consider what qualities are required, that is to say, in what manner a machine is most likely to be used in war.

Now there are three principal circumstances under which British troops may be employed on service, each of which would seem to require a somewhat different type of machine :—

1. *At home, in case of invasion.*—Here, where roads are comparatively plentiful and good, and supplies usually obtainable in the thickly populated districts, the great object of the cyclist would probably be to dash about the country in the lightest order. A light machine might then do, as even repairing and replacing will not be so great a difficulty.

2. *Abroad, where the roads are good and plentiful,* yet where it may be necessary to carry provisions and supplies to last several days. This would involve more of a weight carrier and a stronger build.

3. *Abroad, where the roads are comparatively few and bad.*—There the whole action of cyclists would be much curtailed. Speed would probably have to be sacrificed to solidity. A specially *strong* machine would be necessary to stand the rough work, but it would be more unlikely that the cyclists would be despatched far distant from the main force, so that they would seldom have to carry supplies.

It is in the first of these categories, for home defence, that the cyclist would probably prove of the greatest value. Not only are the roads good and plentiful and well known, but our organisation for home defence is notably deficient in cavalry. But in an enclosed country like England the action of cavalry would be very greatly confined to scouting along roads, and for this particular purpose cyclists are undoubtedly superior to horsemen.

But to properly investigate the suitability of various types of machines we must further sub-divide the subject, and I suggest the following various ways in which cyclists may be employed:—

1. *Strategical, i. e.,* as a method of conveying rapidly comparatively large bodies of troops to the seat of war. They may thus rapidly concentrate on any point independent of railways,

the machines being solely for use in the *strategical* sense for conveying troops to their destination, where the machines could be left stored, and the force act as ordinary infantry. Suppose, for instance, news was suddenly received that an invading force were threatening to land on our coasts—anywhere between the Thames and the Isle of Wight, a battalion mounted on cycles could be despatched from London, and within 5 or 6 hours be on the scene, without waiting for trains to be prepared or other arrangements made, and leaving the railway quite free for the transport of stores and supplies, and other troops. Not only one battalion, but a dozen could be sent, utilizing different by-roads which would have been well surveyed and considered beforehand.

This should be a *most* important factor in home defense. It might even be possible to have the greater part of the Volunteer Force so organized, since nowadays most men ride and possess bicycles, and occasional practice rides would be sufficient training. Troops could thus be brought to the theater of war from all parts of the country by stages, marching their 40 or 50 miles a day.

And this, of course, not only applies to home defence in England, but in many cases, to the defence of our great Colonies, and especially to operations in India.

It may be objected that such large bodies would involve enormously long columns. So they may ; but, after all, they would not be so long as columns of cavalry.

Incidentally, while speaking of Volunteers as cyclists, I hear it said that many of our young men and those most suited for Volunteers, prefer going for their bike ride on a Saturday afternoon to doing a bit of steady drill in the barrack square. The extension of Volunteer cyclists then might be a great incentive to Volunteering, and properly organized military tours would doubtless prove popular.

For this particular mode of employment, Volunteers would of course have to use their own machines, and no one special pattern could well be adopted. But for Regular troops it might be desirable to have stores of bicycles ready. Such machines, merely to be used as a mode of locomotion, enforce no very definite qualifications. They would be primarily for use on fairly good roads, not required for long or severe use, and need not be arranged for many of the purposes to which I shall presently refer. Cheapness, and compactness for storage, would then be the most sought-for qualities. It may also be desirable that such a machine should be a good baggage carrier, so that kits and provisions, and a good supply of ammunition could be carried. On the other hand, under such circumstances, stores of all kinds might be rapidly sent to the front by the otherwise unencumbered railways.

But such a mode of marching is applicable also to other forms of warfare than the defence of our shores. One is often apt to look upon war as a series of battles, and to forget that for every day of fighting there are perhaps twenty or thirty spent in marching quietly along the roads from place to place. Wherever roads are good and plentiful, large bodies of infantry on cycles could be beneficially employed. And indeed there are many countries where roads for wheeled traffic are unknown, yet where the native tracks are eminently suitable for cycling.

2. *Raiding.*—The next use of cyclists which we will consider is what may be included under the head of *raiding.* I am not exactly referring to that species of warfare as exemplified by certain recent operations under Dr. Jameson, but I mean a rapid march into the enemy's country for some particular object, such for instance as the destruction of a railway bridge, the cutting of communications, or even the relief of a more or less hemmed-in force. In these cases, celerity is all-important, yet hard fighting may be expected at any moment.

For such a purpose, given good roads, cycles would be of the greatest use, since distances could be covered in a short time by this means, such as would be impossible even to horses. But it demands a really good machine. Every little breakdown would be fatal. Qualities for speed, weight-carrying, and strength are essential.

3. *Scouting and Reconnaissance.*—For these purposes also cyclists will be most valuable, especially when there is a deficiency of cavalry. As a rule, patrols would be sent out from camp to go a certain distance and return, so that but little weight need be carried on the machines, beyond the rifle and a small supply of ammunition. This may be either for watching the enemy or only for surveying the country. It would be especially useful for outposts.

Under this heading may also be included the advance and rear guards of a force on the march, for which cyclists are eminently suitable, being able to keep a long distance ahead of the force (or behind in retreating), yet able to rapidly send back word when the enemy is met or obstruction is to be cleared.

4. *As Mounted Infantry to a force of all arms.*—It has often been said that mounted infantry must not ape cavalry, and authorities on military cycling have generally decided that this is still more the case with cyclists, who, they say. possess *no shock action.* And, though this may generally be the case, still, given favorable open ground—such as smooth level grass—a force of cyclists, especially if they be armed with revolvers, might well ride rapidly down upon a force of broken and demoralized infantry, and on getting to close quarters drop their machines and charge home. Under this heading would of course be included their employment *as escorts or convoys* to cavalry, guns, or rapidly moving columns of supply. They would be most useful with the cavaly screen, supplying not only a readily available force of infantry, but save much time and work in keeping up communication with the main forces.

Great speed would not usually be called for, but the force must always be prepared to be away for some days and so carry supplies with them.

5. *As Orderlies and Messengers.*—This is the purpose to which cyclists have hitherto been most practically put. As such, the man would usually carry no impedimenta. He might even as a rule go unarmed. Rapidity is important here, and a very light machine would suffice. It is not only in and about camp that such would be most useful, but also, in a lesser sense perhaps, owing to the difficulties of cross-country riding, for carrying despatches and messages in the field.

6. *For Transport.*—Now here is a subject which does not seem to have been sufficiently considered. Given a thoroughly strong machine and fair roads, the transport of supplies might be carried out on emergency by cyclists in a surprising manner.

Setting aside the possibility of utilizing such machines as "carriers" or others specially made for transport, I will only refer to the ordinary bicycle, which I believe could on emergency form a novel and rather remarkable means of transport. Thus, for:—1. Collecting supplies from the country round; a most important duty when a large force remains stationary for some time. 2. Rapidly bringing up supplies of ammunition, intrenching tools, etc. 3. Bringing up supplies from the rear to a force moving forward without sufficient transport. 4. For a lightly equipped flying column.

Now, under such circumstances (except the last) we will presume that the force is encamped and not in danger of immediate attack from the enemy. The cyclists would leave most of their kit, arms, and ammunition behind with the force, and proceed at a rapid speed to the locality where they are to obtain their loads. It may be objected that a cycle can carry no great weight beyond its rider, but speaking from experience I know that an ordinary cyclist can carry at least 200 pounds on his machine in addition to himself. This may sound a lot, of ccurse, but we know how a bicycle will bear the weight of three men, one on the handle-bar and one on the step behind. It may not be desirable to constantly impose such a burden on a machine and bump it along bad roads ; but I am now only referring to emergencies ; moreover, it would not be desirable to maintain any very rapid pace, and on hills and bad bits of road it may be necessary to dismount. Still, it would probably be quite practicable to maintain a speed of five or six miles an hour over a good many miles of average road, carrying at all events a hundredweight. And look at what this implies. A G. S. wagon with four horses takes a load of 30 cwt., that is as much as thirty cyclists. A horse requires about ten times the weight of food that a man does, and is of no use except for transport, and requires men not only as drivers but also as escort. Therefore the four horses consume as much food as forty men. The wagon wears out the roads and is liable to block them if a break-down occurs, and cyclists would make two or three journeys to and fro over the same road bringing up supplies in the same time that the wagons made one.

Under this head we may include the conveyance of wounded in an emergency. We have seen at the Military Tournament how a man can be carried on a stretcher between two bicycles, even if the poor patient did prefer to be left to die in peace rather than be conveyed by this precarious method.

7. *Special purposes.*—There are certain other purposes to which bicycles may be applied. Thus, *signallers*, who now, when on the march, have to stand and despatch their messages and then run after their battalion to catch it up, would find bicycles most convenient. Military *telegraphists* have used cycles in America with most satisfactory results for carrying men to repair their wires.

For *topographers* bicycles are of course most useful. In marching with a column, frequent halts can be made to fill in the sketch or report, and the column rapidly caught up again. Side roads can also be examined ; while the machine itself forms a most useful instrument, as a cyclometer, clinometer, plane-table, etc., can be attached to the machine. *Cooks* and men to collect fuel, etc., being mounted could remain behind and clear up and leave camp long after the column had started, and passing it, may arrive at the new camping ground to get well prepared before the arrival of the force.

Having thus considered the different object for which a cycle is suitable, we must briefly consider, before discussing the details of the machines, the *ground* over which we may want to operate.

Roads.—Of course, everything, from the cyclist's point of view, depends on roads, but there is one point to remember. As regards the use of cyclists over the line of communication, whether for orderly work, conveyance of troops, transport, etc., when the same road will be perpetually used, it would be comparatively easy to keep a track in good repair. In wild countries it would be much easier to make a narrow cycle track than to build a regular cart road. Such tracks could be rapidly cut through forests or over rocky mountains. Even a boarded track would not be difficult to lay in many places, such as over marshy ground. There is a vast difference between making a smooth track a foot or two wide, and a roadway to stand heavy traffic, say, 20 feet wide.

Tracks used by bare-footed natives are generally suitable for cycles—so long as the gradients are not too great, or roots numerous. The sharp stones and thorns that would puncture a pneumatic tyre would also puncture a native's foot, and would therefore not exist in much-frequented paths.

In snow too, so unfavorable as a rule for cycle riding, hard tracks can soon be formed.

But cyclists are not necessarily entirely confined to roads. Large tracts of open plains are frequently met with over which cycles could travel in any direction, and though perhaps such cross-country riding may not be rapid or pleasant for ordinary touring, yet with proper training military cyclists should be able to do a lot of cross-country work.

PART II.

THE BEST TYPE OF MACHINE:—GENERAL TYPE—"BANTAM" AND FRONT DRIVERS—FOLDING—TRIPARTITE—TANDEMS—MULTICYCLES—DETAILS OF CONSTRUCTION—TYRES—CHAINS AND GEARS—MUD GUARD—MINOR ACCESSORIES—SADDLES—BRAKES—ARMAMENT AND EQUIPMENT—ARMS—MACHINE GUNS—KIT REQUIRED.

We will now consider the most suitable type of machine for general service.

The usual build of safety bicycles of to-day—and there is no very great variety—is the outcome of years of practical experience. It is the survival of the fittest of a vast number of patterns and a multitude of eccentricities. We should therefore take this as our groundwork. There are, however, a few qualities which a military machine calls for, which are not of importance in the ordinary machine, and which it will therefore be necessary to add.

The first consideration of a military machine is that it must be thoroughly strong. A light machine cannot be expected to stand the roughing of a campaign. It is probable that this will necessarily involve *weight*, and it will not probably be possible to make it much lighter than forty pounds. The new French machine (*not* the "Gérard") weighs forty-five pounds.

It will of course be necessary that all parts should be interchangeable, so as to facilitate repairing. The parts usually plated should be dulled or blued so as not to glitter in the sun.

As for material, though steel is usually considered better than aluminium or bamboo, that great authority, Mr. J. K. Starley, is in favor of a metal that will not deteriorate by oxidation. He suggests aluminium if a method can be found of satisfactorily joining it, and phosphor-bronze for certain parts, such as the spokes.

As regards the general form, it would be best to have the two wheels of the same size, so that the tyres, etc., could be interchangeable.

It is a pity a bicycle does not float in water. Not only in swimming rivers would this be desirable, but the capsizing of a boatful of cycles would now be a serious matter. Its displacement should support about twenty pounds, and if all the tubing were bigger, it might be made to float. The tubing of a bicycle might easily be arranged to form a reservoir for water. The handle bars alone would hold just a pint, and if detachable, might almost take the place of the water-bottle. Oil, too, not only for lubrication, but for lamps, could be kept in some portion of the tubing.

There is one type of machine, however, still popular in some quarters, which is of different form to the ordinary pattern of safety. I refer to that known as the "Bantam." This possesses one great advantage of being only 4½ feet long instead of the usual 6 feet. This is not only of value as considerably shortening the length of a column of cyclists, but is also of value in storing the machines, and making the cycle more generally handy. Its weight, too, is less than other machines, it being of more compact build, while its neat gearing I will refer to later. On the other hand, the "Bantam" may not be as good for general riding purposes.

But, after all, it is possible to make a machine shorter without necessarily designing it after the model of the "Bantam." With smaller wheels and a shorter frame, a compact and stronger (or lighter) machine may be made. A small wheel is bound to be both lighter and stronger than a larger one in which the same sectional size of spokes, tyre, and rim is used. By making a lower frame, even if not so handy in turning, it will be possible to "toe" the ground and stop without dismounting.

We then come to a type much advocated in some quarters for war purposes, *i. e.*, the *folding* machine.

Colonel Pilleau, R. E., says:—"I think it is now accepted as a fundamental truth that a military cyclist must be mounted on a folding machine."

Captain Gérard, of the French Army, is, I suppose, the originator of such a machine, and having had a good deal of practical experience with it, pronounces very strongly in its favor. His machine certainly does not appeal to the eye of the practical cyclist. The fact of the rider being directly over the hind axle, a special feature of the "Gérard" patent, not only does not look well, but Lieutenant-Colonel Douglas, R. A. M. C., who has ridden about 1,400 miles on one, tells me he has found frequent trouble with burst tyres and worn-out bearings from this cause. The single tube, too, joining the wheels has a decidedly weak look, although it seems to have stood plenty of rough work abroad. The weight is 32 pounds, and it takes 40 to 45 seconds to fold or unfold.

All the other folding machines I know of are made with a frame very similar to the usual one, but jointed with hinges in the upper and lower tubes. In the "Offord" machine these hinges are made in the ordinary frame tubes, and, when set up, a sleeve slides over each hinge. In the "Folder" the tubes are prolonged so as to overlap, and a vertical tube strengthens the frame. The "Belgica," of which a large number has been purchased by the Belgian Government, has a second backbone, all these tubes being hinged in the middle. In the "Alstrom" only handle bars and pedals are folded.

Folding machines seem to be in great favor among the authorities abroad. The report of the Austrian manœuvres of 1896 says: "The difficulties of the ground have, so to speak, disappeared in presence of the folding cycle." After the German manœuvres of 1897 it was said, speaking of the best pattern of war cycle, "It can hardly be doubted that a folding machine is preferable." Both in Spain and Russia a number of folding machines of the "Gérard" type have been under trial. In Italy, too, a cyclist company has been formed, of which half are on folding cycles.

The advantages claimed for a folding cycle are:

1. That when a piece of rough ground has to be crossed it is desirable to be able to fold the machine and carry it bodily over the ground. This applies to heather and long grass, to rocky country, to marshes, and also to steep hills, up which it becomes very difficult to push a heavily burdened machine. Such advantage is specially noticeable when a cyclist detachment, in skirmishing up a hill, or over rough country, to clear it of the enemy, leaves the machines at the bottom, and then has to return down again to get its machines.

2. Compactness in storage especially for railway and steamer traveling. With the usual form of machine it becomes very difficult to stow away any large number without rendering them liable to damage.

Some objections have, however, been urged against such machines. It has been said that the occasions are few and far between when the ground is so bad that the machine cannot be wheeled, though I think such ideas must be gained from experience during peace-time and manœuvres when cross-country work is usually much restricted. Also that on such occasions any machine *can* be carried on the shoulder, though not comfortably or in such a way that the rifle can be used. It is also urged that a man cannot carry the weight of a full kit and a bicycle as well. But even here it must be remembered that he only carries the bicycle for a comparatively short distance, and that on many occasions he would be in light order, having left his kit in camp. Again, it is urged that a considerable time would usually be wasted in strapping the machine on the man's back and undoing it again. So far, however, these may be considered as negative objections, in that they point to a folding machine not being a necessity rather than to its being objectionable. The actual objections are that the makes of folding bicycle referred to are necessarily more or less heavy and complicated. If made light they must be weaker than an ordinary machine, and though a pound or two extra weight may not be of extreme importance, they all have several bolts and hinges and other complications which *may* get out of order, especially after weeks and months of jolting and rough wear, in getting sand and grit in and receiving bumps and knocks. Simplicity of construction is undoubtedly of great importance.

With these conditions before me I have sought to devise a machine which should be foldable and yet at the same time no heavier or no weaker than an ordinary machine and free from complications. I hit off the idea you see exemplified here, called the "Tripartite" fitting. The machine is *detachable* rather than *foldable*. There is a sleeve in the head which retains in place the balls of the upper and lower bearings, and a wing-nut secures the head clamp which, on being loosened, allows of the handle bars and the steering post being withdrawn from the head. The machine is thus easily divisible into three separate parts, which may then be hooked together, when it occupies a space very little greater than the most compact folding machine. Indeed it possesses an advantage over a hinged folding machine in that the pieces can be arranged *flatter*. I have often taken this machine with me in a railway carriage and stowed it underneath the seat, which would be impossible with other folders.[1]

In this type the ordinary machine is taken (this one is a "Premier"), with its well-tried diamond frame intact, *nothing* is detracted from it, and only a very simple portion added, which does not add ¼ lb. to the weight. The frame is in no way weakened, and very little complicated—indeed, in some ways it may be said to simplify the ordinary arrangement, as should anything go wrong in the head, it is so much easier to take to pieces. It also has the great advantage of being adaptable to any existing machine and at a cost of only a few shillings, and may thus be suitable for Volunteers.

The operation of folding only takes about 10 seconds, and it can then be readily slung over the shoulder without necessitating any adjustment of straps. A man can thus jump off the machine, fold it, have it slung, and be on the march within 15 seconds. He might have crossed 60 yards of the bad ground before a man with a "Gérard" would have had his machine properly fixed on his back. This method of *slinging* a heavy machine also enables a man to readily rest the weight of it on the ground at any moment, as for instance when he kneels to fire. But on the other hand, if it *should* be any advantage to have the machine properly fixed on the back, it *can* of course be done quite easily with this pattern. Moreover, if it should be considered desirable

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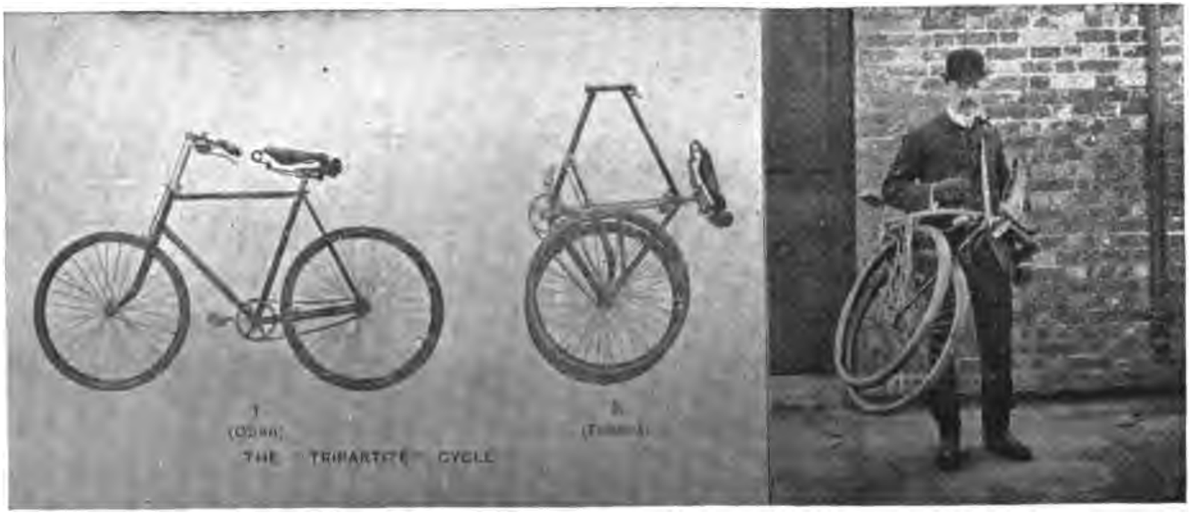
[1] Many of the principal makers, such as the Premier, Rover, Rudge-Whitworth, Marriott, and others, are applying this invention to their machines.



THE "TRIPARTITE" CYCLE

for the man to have his kit on his back there is no room for a bicycle ; but with the "Tripartite" arrangement he can hook it over one shoulder.

There are certain additional advantages in a separable machine. Thus (presuming they were all of one pattern), if three machines became damaged from bullets or other causes, each in a different portion, within a few seconds they could be taken to pieces, and two complete machines be built up. This might be of the greatest importance in action. Then again it would often be of advantage in lifting over walls, etc., to have the weight of a machine divided into three packages. And such an arrangement lends itself to various other devices, such as forming the framework of a pontoon boat or a support to a shelter tent. I will leave it to others more competent than myself to dilate during the discussion on the objections to this form of machine.

There is one other kind of cycle that I must refer to. *Tandems* and *Multicycles* have been tried for military work, and possess the advantages, as compared to a single machine, of being:–1. Lighter in weight per man carried. 2. Slightly quicker. 3. Take up less room in column of route.

They may also prove of use for carrying machine guns, tools, telegraph poles, etc.

On the other hand, the single machine is much handier and easy to stow, and if it breaks down only one man is dismounted, who may get a lift on another machine.

There are however many circumstances under which it might be most desirable for a machine to carry two men, such as the instance just mentioned, or even when a small party of ordinary infantry could be carried by cyclists and rapidly pushed forward or brought back in retreat. At a pinch a man can always be carried sitting on the handle bars. I have myself been thus taken on an ordinary machine for a mile and a half over a hilly and by no means a good road. Mr. Starley suggests a couple of folding steps being attached to the hind axle, on which a man could stand.

As regards other qualities desirable in a military bicycle, I think the first consideration should always be *simplicity*. This would generally imply reduced weight, easier to clean, not so liable to damage or to get out of order. Therefore I should do away, as far as possible, with all accessories such as mud-guards, gear cases, foot rests, etc.

Tyres.—As boots have been said to be the most important part of a soldier's equipment, so we may speak of the tyre as regards a military cycle. But if I were to attempt to describe and discuss the relative merits of all the tyres on the market, I am afraid I should have to keep you here till to-morrow; and as there may be some here who are interested in one or another, I don't know how long the discussion might go on. But I will say one thing. Notwithstanding what advertisements may say, I believe that *all* pneumatic tyres are not only liable to puncture, but also to a certain amount of leakage. The soldier on service cannot always be dependent on his pump; and, be it remembered, it is not only through accident, as with the usual rider, that punctures will occur. On service, were pneumatics used, the enemy would without doubt try various means to wound so vulnerable a point, by scattering on the road not only tacks, broken glass, etc., but even specially constructed obstacles of the nature of "crow's feet." It seems, then, an important matter for consideration whether solid or cushion tyres must not be adopted, notwithstanding their lack of speed and discomfort; and, after all, the old records show that solid-tyred machines were capable of making very fair speeds, the 50-mile record having been accomplished at a rate of no less than 19 miles an hour. There are several new kinds of solid tyre, which may be great improvements on the old. Among them are the "Idris," which has received great praise from some who have tried it.

In the French "Gérard" machines, Michelin's cellular pneumatic tyre is used, which has, I believe, two air tubes, so that when one becomes punctured the other can be blown out.

Mud guards are an addition which I think quite superfluous. They are all very well at home, when it is important to keep the uniforms clean, but on service to have to carry about an extra weight of two pounds, with considerable complication, and great addition to the difficulty of cleaning, is of course absurd. A bullet striking a metal mud-guard, a collision or any other slight mishap, may knock the thing sideways, or gouge a jagged splinter from it sufficient to prevent the wheel rotating freely just at a critical moment. If the machine is fitted with a valise behind the saddle this would form quite sufficient protection from mud, and in peace-time a light canvas arrangement can easily be applied. There is only one point where a mud-guard is really required, and yet, I don't know why, it is seldom, if ever, applied there. I refer to a machine without a gear case. The mud from the back wheel continually spatters right into the chain with palpably detrimental results, yet a very small shield applied in the right place would prevent this.

Chains and Gears.—Chains, however efficient from the theoretical point, are a great source of trouble. Gear cases are objectionable for reasons already mentioned, and also prevent the chain being looked to quickly if anything does go wrong. Without the cases, however, chains are apt to get clogged with mud or dust, and are then apt to get tight and even break. Chains are difficult to clean and keep in good order.

A simple band or ribbon of steel, etc., overcomes some of the above objections; but though often tried, none seems to have proved a success on cycles.

As regards *chainless* gears, there are several going which appear to answer satisfactorily.

1. The *Crypto* gear, in which the pedal cranks are on the axle of the wheel. This is a simple and efficient gear, but it is, of course, only applicable to a front driver, such as the "Bantam."

2. The *Acatene*, or bevel wheel, seems to have stood the practical test of many years' wear. It has the great advantage of being compact and well protected, both from dirt and damage.

3. Lloyd's *Cross-roller* possesses the same qualities, and has also given much satisfaction.

4. The *Cam* gear, on the other hand, is not so compact and neat-looking as the former, indeed, has few advantages over the chain.

Saddles.—I never could find any two people agree as to the best form of saddle. I believe all kinds can be got accustomed to after a few rides, but that all are equally uncomfortable after three or four hours' steady riding. One would become tired of sitting in one fixed position in the softest arm-chair after that time.

Brakes exist in very many forms. Here again simplicity and strength are important, and it has to be remembered that a heavily encumbered military machine requires a powerful brake on an unknown declivity, and that back pedalling under the circumstances is somewhat irksome.

Gear Cases have already been referred to. If really considered necessary, the simplest form should be adopted and metal avoided, since it is more liable to suffer from knocks and dents and bullet wounds. It is essential that it should be easily detachable.

Lamps.—There is a question as to the extent to which lamps will be required. Under the various headings I have put down they would hardly be required, except for *night* marches, which would seldom be made except for the purpose of secretly approaching the enemy, when all lights should be prohibited, and for *orderly* work, when they might be desirable, but this would only apply to a comparatively few machines. Otherwise the lamps would only add to complication, require frequent replenishing and would generally be useless and in the way. It would probably be preferable when required, to affix them to the machine very low (on axle of front wheel), so as not to be seen so easily from a distance.

Luggage Carriers fixed on the handle bars or head or behind the saddle would be necessary, not only for carrying kits, but also other articles.

Rifle Clips.—It is, of course, of the greatest importance to be able to very quickly detach the rifle for use. There are several different methods which have been tried. A very neat clip for holding the rifle has recently been brought out. The rifle is placed between the jaws of the clip (which is merely fixed to the frame) in an upright position, and then turning the rifle so as to lie horizontally the jaws automatically close and grip the rifle firmly.

A *support* to keep the bicycle upright would be a convenience under many circumstances, so long as it was simple and light.

A *coupling* to connect two bicycles together has been invented by Lord Dundonald, and should prove most useful for all transport work.

A *cyclometer* of simple form, such as the Veeder, does not add much to the weight or complication, yet would be most useful for purposes of reconnaissance. Possibly officers only need carry them, but it would be preferable for *all* reconnoitrers to have them so that they would be absolutely accurate in their reports. Thus a scout coming back to report might say he came across the outposts about two miles along the road; but such a distance is difficult to judge, and his report might be of much greater value if he could say it was exactly one mile and three-quarters off. Of course, distances *can* be measured by counting the revolutions of the pedal, but the cyclometer would be more efficient.

A *watch* is another instrument which would be most useful to a cyclist scout, especially if he had no cyclometer.

It may be well for me to add a word or two with regard to the armament and equipment of the cyclist.

Arms.—There are many good authorities who consider the long rifle an indispensable weapon for the efficient infantryman, but there are also some who are not so enthusiastic about it. Thus

Colonel Lockyer, R. A., Chief Inspector of Small-Arms, speaking in this Institution last year, of a universal pattern of firearms for all services, said: "The weapon I am strongly in favor of is a carbine," and then proceeded to point out that, as compared to the long rifle, the present pattern of carbine gives only slightly less muzzle velocity, about the same accuracy, even at long ranges (1400 yards), weighs nearly two pounds less, is eight inches shorter, and therefore more handy, and is easier to clean. It takes the same ammunition as the rifle. I cannot therefore see where the advantage of the extra weight and length comes in.

The French cyclists are armed with the cavalry carbine. So are the Italians.

But for light scouting service, as well as for orderly work, a long-range rifle is perhaps unnecessary. The scout is to see, and not to fight, but he requires a firearm for two purposes:—1. To make a feint and cause alarm, then accuracy of fire is of little importance. 2. To protect himself if suddenly waylaid or attacked by a small party of the enemy. For both these purposes a pistol is as good as anything; indeed for the latter it is the only weapon. A cyclist going along a road and finding his way barred by two or three of the enemy would be at their mercy had he nothing to rely on but a rifle, which he would have to dismount to use, but with a handy revolver or other pistol he can keep going straight ahead and pot his opponents at close quarters. A few cyclists might even, under favorable circumstances, make a regular charge. A Mauser magazine pistol or, better, carbine, might come in well here, although, as pointed out by the above-mentioned authority, it is somewhat complicated and has too light a bullet to have much stopping power. I find it, however, very easy to take to pieces, so that any part could be rapidly replaced. As for range the service Webley (·44 bore) has actually sent a heavier bullet to the extraordinary distance of 1578 yards! The Austrian cyclists were only armed with the revolver during manœuvres. The weapon must be capable of being used with one hand only.

A light *machine* gun would of course be most useful to a party of cyclists. Mr. Maxim has one now which weighs only 25 pounds, and could easily be carried on a bicycle if others carried the ammunition.

As regards officers, there is one weapon which I unhesitatingly should condemn, and that is the sword. If attached to a cycle, and if not a folding machine, it would generally be left behind when coming to close quarters. If worn on the belt, it would generally get through the spokes of the wheels. I think most practical soldiers will agree that, as far as an infantry officer goes, it is an obsolete weapon. Simplicity is its only virtue; but as it generally seems to break directly it is really tried, personally I should always prefer to have two pistols. I say two, in case of one going wrong, as, unfortunately, revolvers are apt to do. A really simple repeating pistol is much needed.

Dress and Equipment of the Cyclist.—Though a big head-dress catches the wind, a belt is uncomfortable when leaning forward, and ammunition boots are not suited to pedals, otherwise there seems no reason why a cyclist should not be dressed as any other soldier, except for the reason that nowadays all smart and artistic effect seems to be discarded as much as possible. Breeches and stockings are all very well, but one can picture the cyclist who, after two or three months of campaigning, has worn them out and gladly adopted a pair of gray socks out of store, and cut short a pair of "tartan" trousers.

Then boots or several pairs of strong shoes *must* be taken. A machine is always liable to break down, and the man may have some long marches to perform on foot. The French carry two pairs of shoes on the machine.

A good deal might be said as to which articles of equipment should be attached to the man and which to the cycle. For comfort (which is nearly synonymous with efficiency), the less the man has on himself the better. But yet, as he may have to fight away from his machine, he should have a good supply of ammunition on him. As he may have at any moment to change machines with another man, he *ought*, also, to keep his own personal articles on himself. But, of course, much will depend on the particular service in which he is to be employed. As a machine may at any moment have to be abandoned, it is essential that the kit carried on it should be readily detachable.

I think every one is more or less in agreement as to the efficiency of a bicycle for employment in war, but it is most necessary to bear in mind that that efficiency is dependent on the exact form of machine used, and if we are not careful to select a suitable build, formed of the most suitable materials, and fitted with most suitable accessories, we may discover too late that the efficiency was not so great as we had expected.

Before closing, I should like to add a word of thanks to Colonel Savile, to Major Liles (of the Cyclist Volunteers), to Captain Swindley (also of the Cyclists'), and to many other authorities, who have been so kind as to give me valuable assistance in the compilation of this paper.

PROFESSIONAL NOTES.

ORGANIZATION AND ADMINISTRATION.

Food Supply in War.

The increasing dependence of the United Kingdom upon foreign food supplies, and especially foreign wheat, cannot be viewed with indifference by our statesmen, nor, indeed, by any section of the community. In resisting the demand for an inquiry into the effects that war may produce upon the food supply the Government takes its stand upon a position from which it cannot easily be moved. Free-trade principles may have ruined British agriculture, but neither Conservatives nor Liberals are prepared to adopt any remedy that savors of protection. Moreover, whilst we are told that British landowners and farmers are unable to compete on equal terms with the foreigner, the agricultural industry still affords employment to a larger section of the population than any other calling. It is but natural, perhaps, that efforts should be made to revive the old national industry, and that a compromise with free-trade principles should be regarded as possible by those directly interested in the revival, but it is not with this aspect of the question that we have to deal. The dangers, real and imaginary, to which the kingdom may be exposed in time of war through its increasing dependence upon an artificial food supply were enumerated by Mr. Seton-Karr the other day with commendable moderation, and he was careful to state that the remedies which he asked the Government to consider were by no means in conflict with the national policy of maintaining a powerful navy. This is the right line to take. The Government points triumphantly to the fleet and backs it to keep the trade routes open in any probable circumstances, but ministers do not deny that the price of food must rise considerably in time of war, however powerful our navy. It is with the idea of placing a limit to this rise that Mr. Seton-Karr asked the Government to consider the utility of State granaries, the partial protection of British agriculture, and other remedies that do not conflict with the general principles of national defense. No remedy has yet been suggested that is free from grave economic or political objections. The Government is firmly opposed to State granaries, and for reasons that have been clearly stated again and again. Neither is it prepared to stimulate British agriculture by putting a small tax upon foreign wheat. The objection to State granaries we regard as insurmountable, whilst the reluctance of the Government to tax foreign wheat may be traced to a variety of causes that need not be dealt with here. Those, however, who are convinced that the British navy, however adequate for the defence of the trade routes, cannot in itself avert a serious rise in the price of food will still support the demand for an inquiry.

The effect of a sudden and material rise in the price of bread might cause serious embarrassment to the Government, and possibly lead to internal riots during a crisis in the national affairs. If panic and semi-starvation can be averted by political remedies, it is folly to point to the fleet as the only legitimate safeguard. It is casting a responsibility upon the fleet which no naval force has ever yet in the world's history been expected to bear. The navy can protect the trade routes, and will do so, but it cannot give the country food at peace prices in time of war. Thus the greater our dependence upon an artificial supply the higher the rise of prices is likely to be. That the United Kingdom is never likely to be self-supporting again is pretty certain. It was so in the early part of the century, when the total population of these islands was 20,000,000; but the population has since doubled itself, whilst agriculture has steadily declined, and is likely to decline still further. Some high authorities contend that there are certain months during the cereal year when the national reserve of wheat amounts to only a fortnight's supply; others deny the accuracy of these figures, and state that the supply of food never falls below a three months' reserve. As Sir C. Dilke has pointed out, this is a vital matter. There is a vast difference between a stock of food for three months and half a month, and the country would be glad to know with certainty how the case stands. Here, at least, there is need for an official inquiry, as the reassuring figures given by Lord Playfair in 1894 were unofficially compiled by that nobleman himself. Other authorities contend that there is at all times a sufficient reserve of food to feed the population for a month, but as to the probable prices of food we can only judge by experience. During the Russian War, as everybody knows, the quartern loaf rose to one shilling, though wé were then producing far more wheat in the kingdom than is being grown to-day.

The Government openly relies upon the United States to supply us with food. Mr. Seton-Karr justly observes that it would be safer to rely upon our own colonies. On the other hand, America is greatly interested in supplying us with the food which we do not produce, and it is difficult to imagine circumstances in which the British navy would fail to protect the Atlantic trade routes. The enemy might declare food to be contraband of war, but this action would strike at the American trade and might force the United States into alliance with us against the common enemy. Shipowners must be prepared, of course, for considerable increase in the rates of insurance, however successful our navy may be, yet it is difficult to regard with patience the demand that they should be protected against war risks by any other mechanism than that of the navy. Still, it is the fact that suggestions to this effect have been made at recent shipping conferences. "If each individual shipper were left in time of war to face his own risks," said Mr. Arnold-Forster, "the result would be nothing short of panic in shipping and commercial circles." Why, we may ask, should the shipowner demand any other protection from the State than that afforded to him by a strong navy? Our merchants were content with these conditions in former days, and, as Captain Mahan has shown, the loss of British ships by capture throughout the wars from 1793 to 1814 amounted to no more than 2½ per cent. Referring to this demand, the President of the Board of Trade justly observed that no Government could undertake to act as an insurance company for shipping valued at £1,090,000,000. It would be impossible, he contended, to guard against fraud, as the seas might be covered with worn-out ships containing worthless cargoes. It is no matter for regret that the House of Commons should be required to consider the food supplies now and again, or that the country should be warned that prices will rise considerably in the event of war. Food supply is not, however, the only responsibility thrown upon the navy. The Englishman cannot live by bread alone, but must feed his mills and workshops with raw material imported from beyond the seas. Hence the security of the food supply is but one branch of the larger problem of keeping the trade routes open.

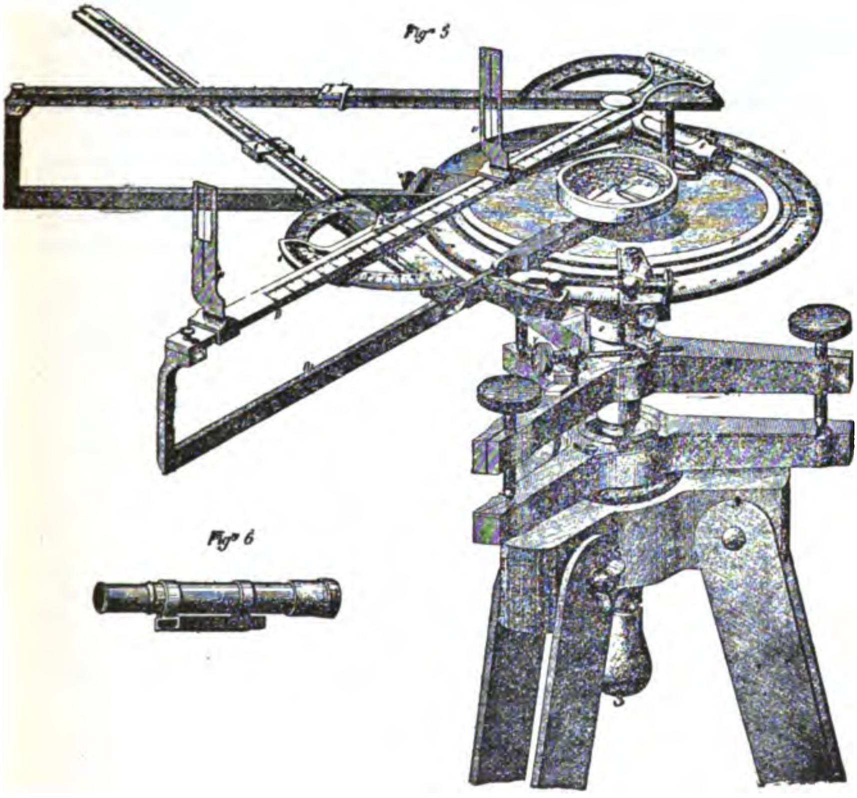
—*Army and Navy Gazette*, March 4, 1899.

BALLISTICS, RANGE FINDING AND POINTING.

The Trigono-Telemeter.

Captain Carlos Antequeda of Buenos Aires has invented a mathematical instrument, which he hopes will be specially useful to the artillery service. The complete instrument is shown in the accompanying plate.

A platform mounted upon a tripod carries an azimuth circle and a surveyor's compass with the usual verniers and leveling attachments, making the instrument at once useful, as the inventor points out, for the measurement of horizontal angles and for determining points of the compass. The novel feature of the Captain's invention is the metal strips lettered A, B, and C, carried by the platform through the bars A1, B1, as shown in the figure. The connection between these strips or rules is such as to admit of forming with them a triangle similar to any given triangle; so that when these parts of a triangle are given, a similar triangle may be constructed with the rules, and the unknown sides read off from graduation upon the rules, and the unknown angles read off from the semi-circles at the vertices.



Captain Antequeda points out that with these rules, apart from the platform, many problems in artillery attack and defense can easily be solved, as it were graphically. For example, the calculation of the protection that a parapet offers; or, in a partial way, the calculation of the ordinate of a trajectory; in general, any problem in which three parts (one at least a side) of a triangle are given, and it is required to determine the other parts. Of course it is not to be expected that this will have any approach to the accuracy of a solution with mathematical tables.

With the rules mounted on the platform and used in connection with the azimuth circles, the inventor has ingeniously contrived to estimate distances, though the accuracy obtainable is not very high.

We append a detailed description of these rules translated from a pamphlet by the inventor.

RULE A.

This rule has a length of .35 m (13″.8) of which 0.10 m (3″.9) corresponds to the diameter of the semi-circle which it carries at one end, and the others .25 m (9″.9) is the rectangular part having a breadth of 0.017 m (″.67) and a thickness of .005 m (″.20).

This rule has a straight edge formed by the diameter of the semi-circle and its prolongation. It is graduated in millimeters upon a beveled edge, the count beginning at the center of the semi-circle and extending to .28 m (11″), with the centimeters numbered 0.

On the under side of the rule is a slot running parallel to the straight edge and .34 m long (13.″39), beginning at the outer end of the semi-circle and ending .01 m (.″39) from the opposite extremity of the rule.

This slot is designed to contain three metal studs which can run along the groove. One of these carries vernier number 5, with its zero on a piece of metal higher than the rest of the vernier and reaching across the bevelled slope. This vernier reads to tenths of millimeters and can be moved along and fixed at any dimension of the rule by tightening or releasing the stud by means of a screw that it carries.

At .005 m (″.2) from the end of the rule opposite the semi-circle a hole is drilled through which passes the stem of a screw serving to adjust it to the support carried by the platform, when mounted on the lower surface, and to the right and left of this hole are two small perforations into which enter two projecting points from the support.

This semi-circle is graduated from right to left up to 180° and left to right from 90° to 45°; underneath is drilled a hole into which enters a screw that unites the rule to the platform.

Finally, adjusted invariably in the center of the semi-circle is a cylindrical pin which serves as an axis for rule B and which is secured to it by a nut.

RULE B.

Rule B is .363 m (14″.29) long, of which .30 m (11.″8) corresponds to the rectangular part and is .015 m (.56″) wide and .004 m (.157″) thick. The other .063 m (2.″55) is of special shape. In this part is to be noted a circular piece carrying two laminae of metal embacing a piece that contains vernier number 1.

In this rule is a hole for the pin of Rule A, so that Rule B can be made to rotate about A from the zero of the semi-circle to 180°.

On the upper surface of the rule is a graduation in millimeters (with the centimeters numbered), the zero being placed at the center of the hole which receives the pin of Rule A. The graduation runs to 25 centimeters.

At the outer extremity of the rule is a removable sight U (for which a telescope may be substituted), and at the end towards A is another sight which may be approached to within .18 m (11.″086) of the first or removed to .28 m (11.″02).

Both sights may be folded down on the rule; when standing, they are perpendicular to it, and the line of colimation contains the straight edge of the rule.

The vernier No. 1 measures arcs on the semi-circle of rule A, reading to two minutes.

RULE C.

This rule in length and thickness has the same dimensions as Rule A. It carries a semi-circle, like Rule A, and has a straight edge formed by the diameter of the semi-circle and its prolongations. It has a graduation in millimeters on its upper surface (with the centimeters numbered), the zero falling at the center of the semi-circle, and the graduation extending to 28 centimeters. For reading tenths of millimeters, there is a vernier (No. 4).

The semi-circle is divided into degrees, numbered from right to left, and beneath the semi-circle, extending along the diameter is a telescope with a large field, with its optic axis parallel to the straight edge of the rule.

In the center of the semi-circle a hole is drilled in which enters the pin carrying the piece numbered 3. The rule rotates about this pin.

PIECE NO. 3.

Piece No. 3 by means of a groove which fits on a rail on rule B, can be moved lengthwise along B. This piece carries a vernier serving to read the arc of rule C to two minutes.

When placed on the rail of B, the line which determines the zero of vernier No. 3 should coincide with the straight edge of B, and this position should be invariable wherever along B the piece may be.

MOVEMENTS AND USE OF THE RULES.

The telescopes of sights are placed in position only when working with the platform; otherwise they are not put on.

When the rules are adjusted, it will be observed that Rule B can rotate about the pin which the semi-circle of A carries at its center; Rule C can likewise rotate about the pin which is carried by piece No. 3, and can move with the latter along B, and can also move along A.

Rule A can be approached to B to within .05 m (1.″969) of the center of the semi-circle of C, and C can be approached to A to within .02 m (.787″) of the center of A's semi-circle.

OBSERVATION.

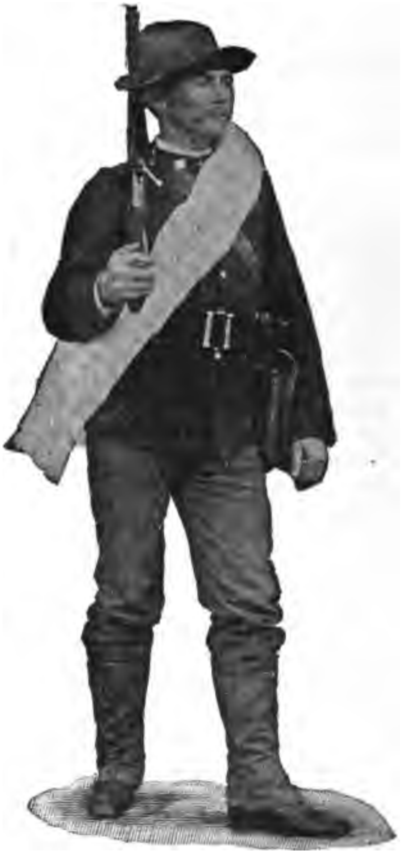
It is to be observed that the angles which are measured by the semi-circles of A and C are respectively equal to the interior angles determined by the straight edges of A–B, and B–C, since they measure angles opposite to these. The angles between A and C will of course be equal to two right angles minus the sum of the angles formed in the semi-circles A and C.

[G. B.]

SMALL ARMS AND EQUIPMENTS.

Rice's Shelter-tent Half, Blanket Roll and Rain Cape.

The recent war with Spain has proved that the blanket roll made out of a shelter tent is preferable, as a field equipment for carrying purposes, to the blanket bag (knapsack) which should be considered barrack furniture and left in the armory. The Board of Ordnance Officers appointed by the War Department to inquire into the experience of the troops serving in the 1898 campain reports:



Rice's Shelter Tent Half in use as a blanket roll for carrying purposes. The lightest and most convenient pack in the world.

REGULARS AND VOLUNTEERS.

"The blanket bag (knapsack) was not used at all, and all the officers were of the opinion that it was useless for field service, and that a blanket roll was preferable and all that was necessary.

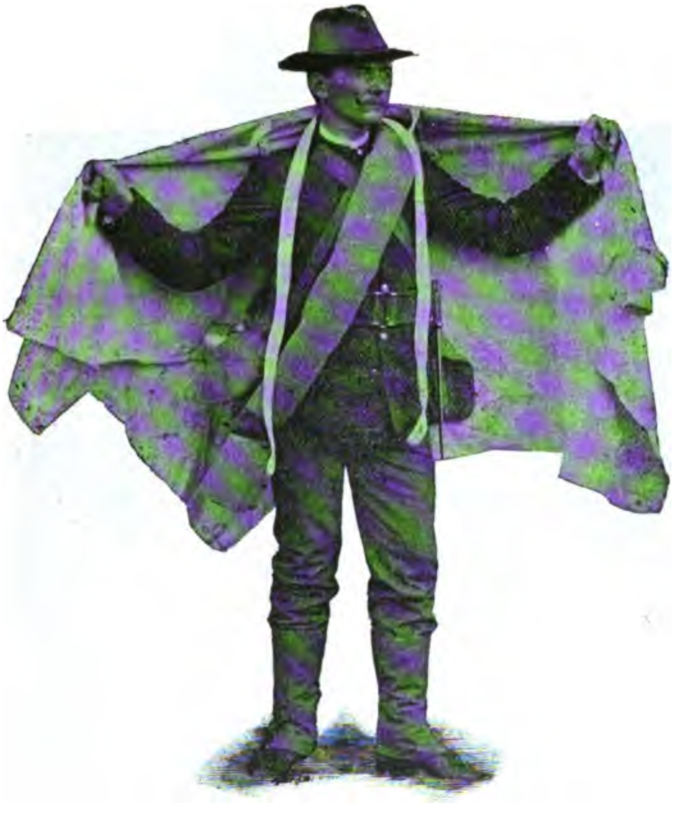
"In barracks the blanket bag (knapsack) is occasionally a useful valise for holding the soldier's spare clothing."

From the *United Service Magazine*, London.

VOLUNTEERS IN 1898.

UNSUITABILITY OF THE NATIONAL GUARD EQUIPMENTS.

"The packs, knapsacks, or valises furnished them added too greatly to the weight carried, and were thrown away with the connivance of the officers. The load they were expected to carry was too heavy. They discarded it. It was proven you cannot make a baggage wagon of a volunteer—he will not stand it."

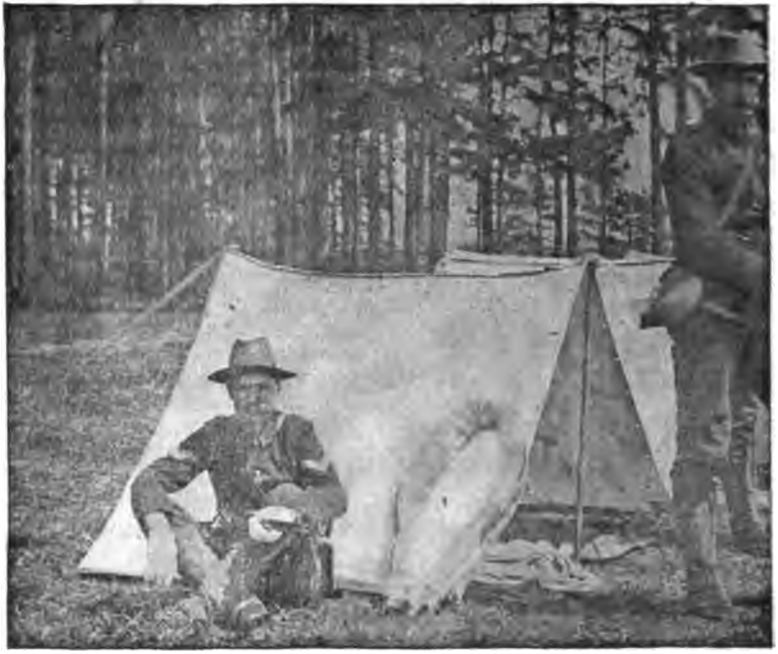


Shelter-half held open, showing how it can be fastened at the neck by the small canvass straps and the guy line and worn as a protection over the blanket roll.

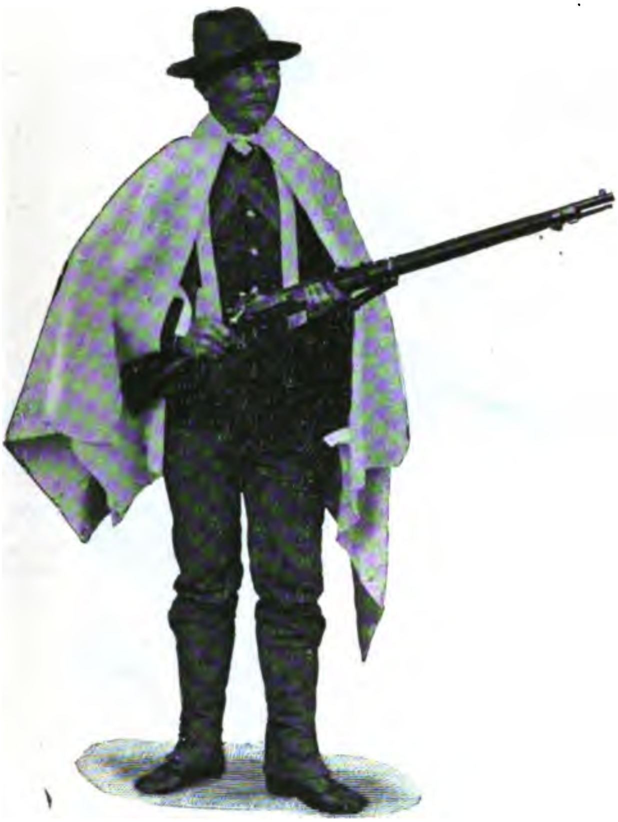
To make a first-class fighting man the soldier must march light.

During the campaigns of 1861 to 1865 and from 1898 to 1899 it was impossible for a man to march and carry on his person any article in the shape of a clothing bag (knapsack) or additional weight, and the reports of the officers and photographs of troops taken in this country, Cuba, Porto Rico, and the Philippines show that the soldier only carried his rifle, ammunition, rations, and the shelter tent roll.

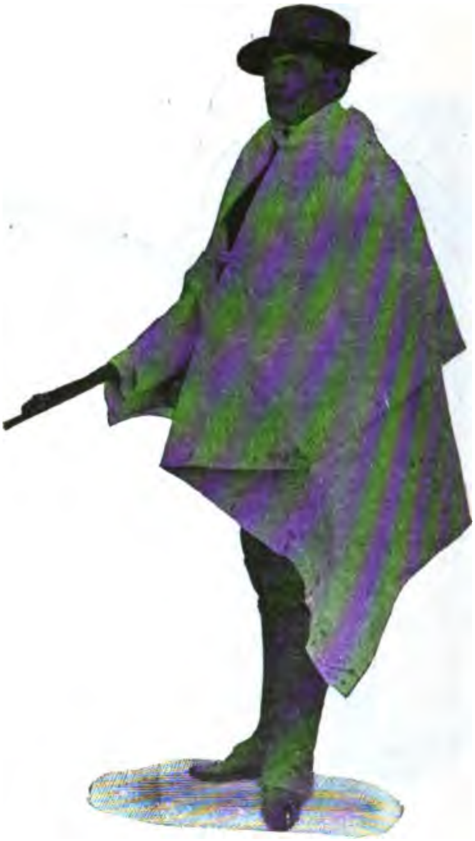
An order to carry the clothing bag, knapsack, valise, or a set of straps to



Two halves make one tent about four feet high with rear closed. No ridge pole necessary. Front and rear poles and pins cut from firewood when command goes into camp. Pins and poles furnished if wanted. By pitching two complete tents with open ends together will make one long tent for four men, completely closed. The long strap is used as a guy line by buttoning on tent and driving tent pin through loop. (Patented).



Shelter-half without the blanket roll, worn as a protection and held in place by the small canvass straps under the chin, and the guy line fastened to the belt. When not needed as a protection, it can be made into a small separate roll, the folds and ends held together by the canvass straps and guy line.



Shelter-half worn over the blanket roll as a protection against rain.

balance or distribute the load hazards the abandonment of the equipment with its contents, and encourages straggling in the worst form. A soldier will not carry on his back a harness or one article simply to hold another.

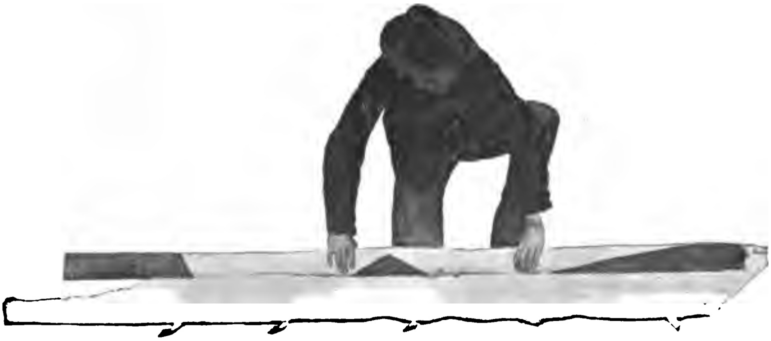
The soldier will only carry necessities on his person when on the march, and officers and men who served in the field report that straps of the same material should be permanently attached to the shelter half so that it may be readily used as a light field pack for carrying purposes and for a rain cape when needed. Straps attached to the shelter half are as essential as are the straps of the knapsack, or as the buttons of the soldier's clothing. To supply the soldier with a shelter tent for carrying purposes without fastenings would be as inconvenient as to give him a coat without buttons. This was proved when the roll burst open and spread itself over the man's person, impeding his progress and forcing him to leave the ranks to fasten it together.

BLANKET ROLL.

INFANTRY.

1. Spread the shelter-half on the ground with the small straps underneath.

Make one smooth fold obliquely across, until one end of each of the small straps is in sight, the other ends of the small straps with the reinforced piece they are fastened to underneath and at the folded edge.



2. Roll up compactly the shelter-half, with the blanket and the necessary articles to be carried.

Roll from you in a double thickness; rolling the ends of the shelter-half towards the small straps at the folded edge; then fastening these straps around the roll.

3. Bring together the two ends of the roll; so that the exposed edge of the material may be on the outside, the reinforced piece forming the outermost line around the roll. Fasten the ends together with the guy line, and it is ready to be carried on the shoulder.

The shelter tent half issued to the troops for the 1898 campagin was the old model without permanent straps or any method of fastening the folds of the roll together.

To remedy this defect, the men used strings and other temporary fastenings, but they were soon lost on the march, and when breaking camp in the dark.

The new shelter tents have permanent straps attached.

BOOK REVIEWS.

Who's Who in America. 1899-1900. Edited by John W. Leonard. Chicago : A. N. Marquis and Company. $2.75.

This timely and useful volume enters the literary world as a kind of surprise, for it has had no predecessor in this country, and yet it immediately becomes indispensable; all libraries, universities, colleges, public offices, journalists and authors will want it, and every private office and library will soon find it so useful that they cannot do without it.

It is a great undertaking, and one for which this busy world should be very grateful. No doubt it has errors, but as this is a work that needs encouragement, and as the editor himself is fully aware of all its imperfections, we will not search for them, but will merely call attention to what it has aimed at and what it has accomplished.

The author has not made it a *blue book*, but rather made *achievement* the criterion in selecting the names. About 8600 persons are biographically sketched, and, although the data given are brief, they are sufficient for the purpose, and include (what will be of great value to many) the addresses of the persons described.

It is well printed and neatly bound, and constitutes a handsome volume.

J. P. W.

Das Bein und Hufleiden der Pferde. Spohr, Oberst a. D. Leipzig : Arwed Strauch. Pp. 175. 3 Marks.

This small volume on the diseases of the horse is the result of thirty-three years of experience and observation, and prescribes methods of treatment without the use of drugs, viz : baths, douches, compresses, etc., for all the *external* troubles of the horse, a second forthcoming work treating in a similar manner of his *internal* troubles.

The pages are closely printed and there is much useful information contained in them, and there is little doubt that many a horse would be saved for his owner if the latter knew the simple and effective remedies here described.

The author claims to have had great success in the treatment of his own and other horses by this so-called *natural* method, and we recommend the work for all such troubles as can be treated by any intelligent person, and which are not dangerous enough to require an expert immediately.

J. P. W.

Kriegsgeschichtliche Beispiele aus dem deutsch-französischen Kriege von 1870-71. Von Kunz, Major a. D. 10. Heft, E. S. Mittler und Sohn. Pp. 138.

Number ten of this series of military historical examples illustrates by the battle of St. Privat the subject of the attack and defense of villages, and in the clearness of description and the multitude of tactical points illustrated it is a masterpiece and a model.

The author begins with a description of the field, derived from careful study on the ground itself, then gives a brief summary of the situation before the battle and finally takes up the battle itself. The battle proper opens with the action of the *artillery* of the Guard preparatory to the attack of the *infantry* of that corps. Then follows a most interesting discussion on the considerations that determined Prince August to order the assault by the infantry before the artillery had adequately prepared this attack, from which we quote the following:

"From this it appears that Prince August, shortly before 5 p. m., had a perfectly clear and correct conception of the military situation and state of affairs, and was thoroughly impressed with the importance of preparing for an attack on a large scale on a strong position by means of powerful artillery fire. What happened, therefore, between 5.00 and 5.15 to cause Prince August to alter his true conception and to tempt him to a hasty attack, the consequences of which were practically the annihilation of the infantry of the Guard?

"Herein lies a riddle, the key to which can be found only in the personal relations existing between Prince Frederick Charles and Prince August of Würtenberg. Prince Frederick Charles it appears, did not have a very high opinion of the abilities of Prince August as a corps commander, moreover Prince August was well aware that he was not a favorite of Prince Frederick Charles. Finally, that Prince Frederick Charles had no great affection for the Guard had already appeared in the campaign of 1864.

"After the war of 1870-71 it was common talk that, on the 18th of August, 1870, about 5 o'clock p. m., Prince Frederick Charles made a very severe remark to Prince August, to the effect that the Guard Corps had fought very *indifferently*, and that such lukewarm action does not *decide* battles.

"The rapidly setting sun has been referred to in explanation of the decision of Prince August to attack. But at 5 p. m. Prince August was not in the least concerned about the setting of the sun, or he would not have sent to Prince Hohenloke the message * we know was sent. In a quarter of an hour the sun does not sink so much, on or about the 10th of August, as to explain Prince August's complete change of view.

It is therefore probable that Prince August, in consequence of the facts set forth above, had a strong Inclination to attack, and that the remark of Prince Frederick Charles scattered to the winds all considerations against attack."

The infantry attack is divided into six stages, each discussed separately but in such a way as to give a clear picture of the entire situation at all times.

(1). The attack of the 4th Brigade, Infantry of the Guard.

(2). The attack of the 1st Brigade, Infantry of the Guard.

(3). The entrance into the battle of the 2nd and 4th Regiments of the Guard.

(4). The capture of Roncourt by the Saxons and part of the 1st Division of the Guard.

(5). The action of the Guard artillery from 5.15 p. m. to the final assault on St. Privat and the preparation for the assault by the Saxon artillery.

(6). The final assault.

The work concludes with an excellent time-table of all that took place from 11.45 a. m., when the first cannon was fired by the IX Corps, to 9 p. m., when the last stand of the French in the interior of the village of St. Privat was broken ; a table of losses sustained by the different subdivisions ; a consideration of the principles of tactics illustrated in this battle ; and finally, a series of problems (40) set for students of tactics, with a list of works to be consulted in their solution.

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* To the effect that he would be informed a full half hour *before* the infantry attack, so hat he could concentrate the fire of the entire artillery of the Guard on the point of attack preparatory to this movement.

This number is printed in the excellent manner of the preceding numbers, and has appended a contoured map of the field and a sheet of diagrams giving in section (drawn to scale) the slopes passed over in the attack.

J. P. W.

Reminiscences of the Santiago Campaign. By John Bigelow, Jr., Captain 10th U. S. Cavalry. New York and London : Harper and Brothers. Pp. 187, with map.

Captain Bigelow, already well known to the military world by his studies of the battle of *Mars la Tour and Gravelotte* and his work on the *Principles of Strategy*, commanded a troop in the Tenth regular cavalry that fought so nobly at Santiago.

Much has been written on this campaign, and many have been criticised for the faults so evident to all, but we doubt if there is any other work that tells so clearly what was amiss and yet remains so entirely free from any personal feeling. The author tells the tale of his experience in a simple, straightforward way, and, although he shows clearly that there was blundering, he does not pretend to estimate how much or how little of this was unavoidable under the circumstances, nor to fix the blame on any particular individual or class of individuals. He merely tells us what he saw, and leaves us to judge where blame should attach.

His reason for writing the book is set forth in the Preface :

"On my return from the Cuban campaign in July last, I found the community into which I was thrown during my convalescence intensely interested in every detail of the experience of any one who had participated in it. The space subsequently given in the public prints to the proceedings of the President's Commission for Inquiring into the Conduct of the War has led my friends as well as some publishers to urge me to allow the general public to share such information about the campaign as my observation and experience enables me to impart. It is in deference to these considerations that these pages, revised from my correspondence with my family, are submitted to the public. They make no pretension to be a history of the late war, nor even of the campaign of Santiago, but simply what the title implies—a narration of what an officer participating in that campaign saw, felt, and thought, with such explanations and suggestions as his observation and reflections prompted."

His story opens with an account of his efforts to join his regiment from the Massachusetts Institute of Technology, where he had been on duty as military professor, and the experiences recounted are sufficiently amusing, interesting and instructive.

On joining his troop at Camp Thomas, Georgia, his troubles with regard to equipments and supplies began, and we quote a few sentences in illustration :

" Finally, requisitions were made out for articles to replace those which were to be condemned and those which were missing. The inventory and inspection reports were acted on several weeks later in another camp. The requisitions had soon to be made over again, because, as I understood, they were lost at division headquarters. Even this second edition was practically never filled. The bulk of what it called for was received, I believe, in the detention camp at Montauk Point, after the campaign of Santiago."

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"Many of the men had no rubber overcoats or slickers (oiled canvas coats like sou'westers), there was no prospect of any being furnished by the government, and the Quartermaster's Department did not even have such an article for sale."

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"There was no sign of a summer uniform. Men and officers were wearing the uniforms which they wore through the winter in Montana, except that they commonly left off their blouses."

As regards military instruction in the camp and organization, he makes the following pertinent remarks:

"Camp George H. Thomas, as our camp was called, was to me a great disappointment. I expected to find it a camp of instruction, in which advance and rear guard service, the tactics of infantry, cavalry, and artillery, separately and combined, would be illustrated and taught practically on a large scale. I expected to find the camp covered with pickets as it would be in the presence of the enemy, and to take my regular turn at outpost duty, to practice patrolling and reconnoitring beyond the outposts, to see large bodies of troops manœuvre against each other and deploy, and go through the forms of an attack and defence. I saw nothing of the kind. Most of the drilling that I did was by company or troop."

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"I was already impressed by the fact that the navy was making a better showing in the war than the army. The navy had a general staff school, and had worked out plans of mobilization in advance. The army had no general staff school. Brigades, divisions, and army corps were organized and placed in camps; and instead of being trained and sent to the front as units, were trained by companies and sent to the front as regiments. When a brigade or division was wanted for Cuba, Puerto Rico, or the Philippines, it was formed by taking a regiment here and a regiment there."

Such thoughts went through the minds of many other thinking officers besides Captain Bigelow. In the next movement, by rail to Lakeland, Florida, other complications arose:

"The loading, especially of the horses, was attended with confusion to be expected in the absence of a general staff-officer, or other official competent to control both the troops and the railroad. The trouble in moving troops by rail in our country arises chiefly from the ignorance of railroad matters. Horses were put into cars with their heads where their tails ought to have been, but the railroad people did not care, so the cars were loaded and the train moved out. I heard that they tried to get the regiment off with one car less than the contract called for, but the regimental commander properly insisted on having that car, though it should go empty."

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"As some of the horses faced one way and some the other, they had dropped more or less dung in the troughs on each side of the cars. The troughs were designed to be emptied by turning them over, but the mechanism by which this was to be done would not work, and as a consequence the horses had to be watered with dung and water, which most of them sniffed at and would not drink."

* * * * * * * * * *

"This evening (May 15) my section caught up with Captain Reade's at a station where both sections remained long enough for Captain Reade and myself to take supper at a restaurant. We heard it rumored here that our destination had been changed, as it had been found at Tampa that there was no suitable camping-ground there for the Tenth Cavalry. We realized that we were absolutely in the power of the railroad company. All that we had to do, and it was more than I succeeded in doing, was to keep our men from being left on the road. I lost two or three of my men, who were picked up by the section in rear of mine. When we started again we understood that we were going by a branch road to our new destination, but where this was, or when we were to reach it, we could not guess. I expected to be enlightened on these points by telegraph, but I was not. When I woke up, at five o'clock the following morning, I found my section without an engine—side-tracked at a place which proved to be Lakeland, Florida."

The author again indulges in reflections on the character of the drill in camp, and the lack of preparation for the campaign in hand :

"The change in the time and duration of the drill was ordered from division or corps headquarters on account of the heat. I thought this a singular measure in our prepartion for a campaign which might involve marching and fighting at all hours of the day and night through a tropical summer. But far be it from me to criticise. I wish only to record that the philosophy, or rationale, of our training at this time was too deep for me.

"As to brigade instruction, there was none. The regiments were not united for a single parade, review, drill, inspection, field-exercise, or anything else. During most, if not all, of our stay near Lakeland, the brigade commander had his headquarters in a hotel in town. His regiments were never formed in the same line of battle until they came under the fire of Spanish rifles. It is hardly necessary to add that there were no division exercises. The division commander visited the camps once. He did not have the regiments united or mounted. His inspection of the Tenth Cavalry consisted in walking through the company streets dismounted, and interviewing the officers. This was the only inspection made of our regiment during the campaign, except by officers of the regiment. I do not remember seeing an officer of the Inspector-General's Corps inspecting anything."

As regards the volunteer camps (71st New York and 2nd Massachusetts) he states :

"It is hardly an exaggeration to say that there was more dirt in one of their company streets than in our whole camp. I understand that the commanding officers of these regiments were allowed to choose the sites for their camps. If that was the case, they might perhaps have done well to have fixed their choice upon points close to the camps of the Regulars, which would have served as object lessons to them."

The confusion and discomforts at Tampa Bay during the embarkation is still fresh in the minds of the public, and Captain Bigelow, who tells his experience without reserve, confirms the previous reports on this subject :

"To wait for the train, our regiment was marched into an enclosure in the main square of the town, near the station, and there remained in the broiling sun until afternoon—altogether about seven hours. The men were allowed, a few at a time, to go out to a store or restaurant near by. Fortunately they had been paid not long before, and many of them had money. There was no lunch to give them except hard bread. I was going to have some issued, but the First Sergeant told me that the men would not eat it. They would prefer waiting, he said, until we got to Tampa, and could have a square meal. So I made the mistake of not giving them what food I had. I left all the hard bread in the baggage car. We should have had canned meat. Why we did not I do not know, unless it was that our brigade commissary was a Volunteer officer fresh from civil life. However that may have been, this officer proved himself alive to his responsibilities, and fitted himself to fulfill their highest requirements. He was wounded at San Juan while attending to the distribution of rations on the firing-line."

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"After the men were assigned to their quarters I wanted to give my men some supper, and found that there was nothing whatever to give them. The cars containing our rations were several miles behind, and the intervening railroad completely blocked. I went to a restaurant on the pier to make arrangements to have the men eat there, and was told by the lady who kept it that to have colored men eat in her dining-room would ruin her business. After making all possible inquiries, and ineffectually trying every place within reach, I returned to the transport, and sadly told First Sergeant Givens that I felt for the men, but could not do anything to relieve their hunger. Excepting the coffee and hard bread they ate about three o'clock in the morning, they had not received anything to eat from the Government since the night before."

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"Without breakfast, the men were put to work taking the baggage off the cars and loading it on the transport. I was told by my squadron commander to put my baggage on where my men went on, and pile it where they were quartered. When I had gotten about half of it aboard and deposited as directed, I was told by the regimental Quartermaster that all the baggage should be put in the hold in the forward part of the vessel."

The same confusion and repeated changing of the orders occurred at Daiquiri. The advance to Las Guasimas, Sevilla and El Pazo is very graphically described, and the scenes *en route* are depicted with a faithfulness that gives them a stirring reality.

The account of the real author of the attack on San Juan hill is as follows:

"The position taken up as described, within decisive range of the enemy's infantry rifles, our artillery doing nothing to keep down his fire, was soon found to be untenable. Between 9 and 9.30 a. m., General Hawkins, commanding Kent's first brigade, and forming the right of the division, said to General Sumner, in the presence of General Kent, "We cannot stay here. It will not do for us to retire. The only alternative is to attack." And turning to his commander, he added, "If you will authorize it, General Kent, I will move my brigade around here against the enemy's right, and, with General Sumner co-operating, will engage to carry the enemy's position." Just then Lieutenant-Colonel Miley, General Shafter's chief of staff, came up, and

General Hawkins made the proposition to him in the presence of Generals Kent and Sumner. It was about 10.30 a. m. when Lieutenant-Colonel Miley said, "General Kent, if you have no objection, I will order this movement in General Shafter's name." 'Very well,' said General Kent, who then rode off to hurry up the remainder of his division. Neither General Wheeler nor General Shafter had anything to do with the initiation of the attack."

In this attack, in which the author's regiment covered itself with glory, he was wounded, and his experiences in the field, division and general hospitals conclude his most entertaining reminiscences.

He saw much and his general information and natural abilities enabled him to judge of his surroundings intelligently. For these reasons, as well as on account of the calm spirit in which the events are passed in review, his work must take high rank for reliability and truthfulness as well as good judgment on all the matters that came within the scope of his experience.

J. P. W.

Der Krieg um Cuba im Sommer 1898. M. Plueddemann, Kontre-Admiral Z. D. Berlin: E. S. Mittler und Sohn. Marks 5.50. Pp. 250.

Rear-Admiral Pl ddemann has given us in this work a succinct account of the recent campaign in Cuba, from the point of view of an able and thinking foreign naval officer, high in the counsels of his government. The work opens with a short account of the previous history of Cuba and the conditions prevailing on the island. and then discusses the causes of the war. Among the the latter, he speaks of the destruction of the *Maine* in the following terms as regards the conclusion of the investigating commission:

"The American verdict, however, gives the impression of being frivolous (*macht den Eindruck der Leichtfertigkeit*). The separate conclusions were disputed by many experts—the Americans did not have a single shipbuilder (naval constructor) among their members. Party feeling and previous conviction often interfere with true justice in the courts of the civilized world; how much more in a prejudiced commission?"

The author throughout evidently sympathizes with Spain, but especially in discussing the right of the United States to enter on this war. But, on the whole, he is very fair in the expression of his views.

In regard to the bombardment of San Juan, he says:

"The opening of this bombardment, without previous notice and at an hour when darkness concealed the advance of the hostile squadron, was certainly not in conformity with modern views as to the rights of the people in such matters. This neglect to give due notice can only be understood and excused in case a definite military advantage is to be gained by surprise, or at least the possibility of such an advantage. But there was nothing of the kind; even with the most favorable results, further pursuit, for lack of land forces, was impossible. The bombardment was a separate action, which could have been executed quite as well twenty-four hours later, by which time the non-combatants who had to pay with their blood for the thoughtlessness of their deliverers, as the Americans like to call themselves, might have been placed in a position of safety.

"The only tangible result of this action was the information that the Spanish fleet was not in the harbor, and that could have been determined with greater certainty by other methods."

The descriptions of the movements of the two fleets in the West Indies, culminating in the destruction of Cervera's fleet, including the campaign of Santiago on the land, as well as that of Dewey's fleet in the Philippines, are given with an experienced sailor's insight and true comprehension.

The book is well worth careful perusal by navy and army, and will be useful in presenting our late war to us as viewed in the light of one fully capable of passing judgment.

J. P. W.

BOOK NOTICES.

[These books will be fully *reviewed* as space becomes available.]

A French-English Military Technical Dictionary. C. de W. Willcox, 1st Lieutenant of Artillery, U. S. Army. Part I. Washington: Government Printing Office. 1899.

Hygiene of the Soldier in the Tropics. Translated by Captain G. W. Read, 9th U. S. Cavalry. Kansas City, Mo.: Hudson-Kimberly Publishing Co. International Series, No. 7.

Untersuchungen über die Vibration des Gewehrlaufs. C. Cranz und K. R. Koch. München: Verlag der K. Akademie. 1899.

Strategisch-taktische Aufgaben nebst Lösungeu. H. v. Gizycki. 5th edition. Nos. 5 and 6. Leipzig: Zuckschwerdt & Co. 1899.

American National Red Cross Relief Committee Reports, May, 1898 to March, 1899. Copies of this report are on sale at G. P. Putnam's Sons, 27 and 29 West 23rd St., New York City. Paper, 75 cents; cloth, $1.00.

Tactics for Beginners. By Captain C. M. DeGruyther, Instructor in Tactics at the Royal Military College, Camberley.—Aldershot: Gale & Polden, Ltd. 6 shillings.

Organization and Equipment Made Easy. By Captain S. I. Banning, Instructor in Military Administration. Aldershot: Gale & Polden, Ltd. Four-and-six.

Key to Military Sketching Made Easy, and Military Maps Explained. By Captain L. J. Shadwell. Aldershot: Gale & Polden, Ltd. Four shillings.

Annual Report for Fiscal Year Ended June 30, 1899. William Ludlow, Brigadier-General U. S. V., Commanding Department of Havana, and Military Governor of the City of Havana, Cuba. Pp. 288, with numerous maps, diagrams, views, etc.

Remarks on the Economic, Industrial and Social Conditions Existing in the Department of Havana. William Ludlow, Military Governor of the City of Havana.

Electric Railways. Cassier's Magazine. August. With due appreciation of the wide interests in everything pertaining to electric railways, the publishers of *Cassier's Magazine* over a year ago determined upon the publication of a special issue, in which should be embodied everything about electric traction that would appeal to the engineer, the capitalist, and even the layman. The best available engineering talent on both sides of the Atlantic was enlisted in the undertaking; every likely source of valuable information was assiduously cultivated; art and science both were made to contribute to the work, and the outcome of it all was a volume of engineering literature unlike anything ever before produced—a volume which is a text book of enduring merit on electric railway engineering. From the historical survey of the subject to its business aspect, every intermediate phase has been carefully considered, and every noteworthy detail has been worked out by a competent authority, and presented in a masterly manner.

This issue, called the *Electric Railway Number*, contains 292 pages of reading matter, including over 200 engravings, comprising, altogether, eighteen articles, prepared by eighteen of the foremost authorities in the world, and constitutes what has hitherto been lacking in engineering literature—a text book of the first order of merit on electric railways.

ARTILLERY MEMORANDA, No. 1.

HEADQUARTERS OF THE ARMY,

ADJUTANT GENERAL'S OFFICE,
Washington, August 19, 1899.

The accompanying range-table, prepared by Major *James M. Ingalls*, 1st Artillery, for the 8-inch breech-loading rifle, firing Parrott projectiles; weight of projectile, 150 pounds; powder charge, 44 pounds, sphero-hexagonal powder; muzzle velocity, 1,490 feet per second, is published for the use and information of all concerned.

BY COMMAND OF MAJOR GENERAL MILES:

H. C. CORBIN,
Adjutant General.

Range table for 8-*inch breech-loading rije, firing Parrott projectiles; weight of projectile,* 150 *pounds; powder charge,* 44 *pounds, sphero-hexagonal powder; muzzle velocity.* 1,490 *feet per second.*

Range.	Angle of projection.	Difference.	Range.	Angle of projection.	Difference.	Range.	Angle of projection.	Difference.
Yards.	° ′	′	*Yards.*	° ′	′	*Yards.*	° ′	′
2,000	3 13	12	3,400	6 24	15	4,800	10 19	19
2,100	3 25	12	3.500	6 39	15	4,900	10 38	19
2,200	3 37	13	3.600	6 54	16	5,000	10 57	19
2,300	3 50	13	3.700	7 10	16	5,100	11 16	20
2,400	4 3	13	3,800	7 26	16	5.200	11 36	20
2,500	4 16	13	3.900	7 42	17	5,300	11 56	20
2,600	4 29	14	4.000	7 59	17	5,400	12 16	20
2,700	4 43	14	4,100	8 16	17	5.500	12 36	21
2,800	4 57	14	4,200	8 33	17	5.600	12 57	21
2,900	5 11	14	4,300	8 50	17	5.700	13 18	21
3,000	5 25	14	4,400	9 7	18	5,800	13 39	21
3,100	5 39	15	4.500	9 25	18	5,900	14 0	22
3,200	5 54	15	4,600	9 43	18	6,000	14 22	22
3,300	6 9	15	4,700	10 1	18			

REMARKS.

The column marked "Difference" is the variation of the angle of projection (and practically of the angle of elevation also) for a variation of 100 yards in the range. It therefore affords the means of correcting the angle of elevation when the error of the trial shot has been accurately observed. For example, the range is 3,600 yards. The jump of the gun, the exact muzzle velocity, and the atmospheric conditions are all unknown. The gun will be given an elevation, according to the table, of 6° 54′, and the shot is observed to strike 120 yards over. What should be the elevation for the next shot? According to the table, 100 yards corresponds to 16′. Therefore for 120 yards we have a correction equal to

$$\frac{120}{100} \times 16' = 19',$$

which must be substracted from the tabular elevation. The next shot would then be fired with an elevation of 6° 54′ — 19′ = 6° 35′. This method corrects for all the unknown causes affecting the range.

◆

INDEX TO CURRENT ARTILLERY LITERATURE.

PERIODICALS CITED.

Abbreviations employed in index are added here in brackets.

All the periodicals are preserved in the Artillery School Library, Fort Monroe, Virginia.

ENGLAND.

Aldershot Military Society. *Occasional.*
Aldershot. Copies 6d each.

Arms and Explosives. [*Arms and Ex.*] *Monthly.*
Effingham House, Arundel Street, Strand, London, W. C. Per year 7 s.

Army and Navy Gazette. [*A. and N. Gaz.*] *Weekly.*
3 *York Street, Covent Garden, London. Per year £*1 12*s* 6*d.*

Canadian Military Gazette. [*Can. Gaz.*] *Fortnightly.*
Box 2179 *Montreal, Canada. Per year* $2.00.

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Alterations in the Russian army.—**Mitth. Art. u. G.,** 2, 3, 6.

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Marching capacity of troops in mountainous country.—**S. Zeitschr.**, May.

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The squadron as a military unit.—**R. G. de Marina**, June.

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The occupation of positions by field artillery.—**Invalide**, 130.

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The strategic position of England in the north Atlantic.—**R. Maritime**, April.

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CORRECTION.

Page 220. Figure 2 was accidently omitted by the engravers, hence, the succeeding numbers of figures referred to should be 2–7, respectively, instead of 3–8.

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PREPARATION FOR WAR.

BY COMMANDER CHARLES H. STOCKTON, U. S. NAVY, PRESIDENT NAVAL WAR COLLEGE.

Delivered at the opening of the course at the Naval War College, Newport, R. I., May 31,'99.

The great masters in the art of war have announced as an axiom that of all things which contribute most directly and effectually to the success of a military undertaking, Preparation holds the first place.

This announcement and rule, made for the first time many centuries ago, and repeated often since, was never truer or more pertinent than at the present day.

Wars are shorter, warlike appliances more effective and complicated, and military movements more rapid, while the masses of men and material to be manipulated are greater now than ever before in the history of the world. Hence the time of preparation is necessarily longer and more absorbing, the actual war time shorter, more concentrated, and more overwhelming.

A celebrated Englise military writer, in discussing the present military situation in Europe, puts the phases of modern war in a most effective way before us when he says :

> It may well give us cause to speculate upon what may happen at no very distant future; the victor in the coming strife—for come it must—may stand the possessor of unlimited resources, resources which Napoleon never imagined in his wildest dreams; trained men outnumbering his in the proportion of at least five to one; means of transport by sea and land immeasurably greater, independent of weather, and at least five times as swift; means of communication so incalculably rapid as to be practically instantaneous; better food in far smaller compass: and death-dealing weapons lighter and more mobile, delivering with unerring certainty their blows from tenfold distances with twentyfold rapidity.

If Preparation, then, is the first thing necessary to success in war, to no country is preparation more essential than to ours. whose experience in actual war has been meager, whose population and pursuits are normally so peaceful, and whose situation and isolation heretofore has allowed a growth so rapid and so great that we have attained rank as one of the great powers in the world without having been obliged to establish our position by the test of an extensive or great foreign war.

It has been said that great states which have arisen out of chaos require time to consolidate and organize themselves, their whole power and energy being chiefly directed toward that point. During this period of consolidation and organization their foreign wars are few, and the wars that do take place bear the stamp of a state unity not well cemented.

In repeating the statement thus made, we are not only repeating a general truth, but we are also summarizing to a great extent the military experience of our country.

The Revolutionary war, with an existing Tory element; the war of 1812, with New England reluctant and protesting; the Mexican war, with a northern lack of sympathy for the ultimate objects of the conflict, and finally the great civil war, all emphasize the condition of a nation not well cemented in unity nor fully consolidated in strength.

Yet every war brought us closer together, and the first war after our independence, that of 1812, alone made us a coherent nationality. In this connection let me quote from two distinguished men not given to the undue exaltation of war.

Mr. Henry Adams, the historian, says (Vol. IX, p. 220):

> In 1815, for the first time, Americans ceased to doubt the path they were to follow. Not only was the unity of their nation established, but its probable divergence from older societies was also well defined. * * *
>
> The war gave a severe shock to the Anglican sympathies of society, and peace seemed to widen the breach between European and American tastes. * * * That Europe, within certain limits, might tend toward American ideas was possible, but that America should under any circumstances follow the experience of European development might thenceforward be reckoned as improbable. American character was formed, if not fixed.

Mr. Carl Schurz, in his Life of Henry Clay (Vol. I, p. 121), says:

> For the war of 1812, with all the losses in blood and treasure entailed by it, and in spite of the peace which ignored the declared causes of the war, transformed the American Republic in the estimation of the world from a feeble experimental curiosity into a power—a real power, full of brains, and with visible claws and teeth. It made the American people who had so far consisted of the peoples of so many little Commonwealths, not seldom

wondering whether they could profitably stay longer together, a consciously united nation with a common country—a great country—worth fighting for, and a common national destiny—nobody could say how great, and a common national pride, at that time filling every American heart brim full. * * * A war that had such results was not fought in vain.

With the close of the civil and Spanish-American wars, with the definite re-establishment of the nation, and with a consequent increased homogeneity of the country, North and South, should end the period of internal consolidation and begin the development of external strength.

With the new period beginning will come a conflict of interests: First, with other powers with respect to their interests upon the American Continent and its neighboring islands and waters; second, with other great powers as a result of our growing and antagonistic interests upon the great field of the world's commerce.

Out of this clashing of interests will arise occasionally a period of war—at rare intervals we all hope—but none the less certain. For these occasions of war it becomes our simple and natural duty, as members of a military profession, to prepare. The notice will be short, the preparation should be long and thorough.

The preparation of material is necessary, and should go on, but above all the preparation of the personnel, without which the material is nothing, should be the duty of the hour, the day, and all peace time. This preparation of the personnel should include, among other matters for the Navy of the United States:

1. Formation of plans of organization, including plans of a ready mobilization.
2. Preparation for actual war.
3. Formation of plans for operations.

When this preliminary work has been completed, or is interrupted by actual war, coming, as it almost invariably does, without much warning, there is left for actual war time: First, the question of offensive of defensive operation; second, action.

Maritime warfare can be divided broadly into three general forms of action, as follows:

1. The war of fleets and squadrons.
2. War against commerce.
3. Maritime expeditions, combined or naval. (I do not include blockades, as they are either of the first or second form.)

The first form of warfare, which may be called that of grand movements, requires fleets and money; ports and supplies, and the best class of vessels for the line of battle. By means of these grand movements the command of the sea is secured or retained, and as the greater includes the less, so the grand movements give freedom for and allow or accompany the minor movements of commerce-destroying and territorial attack.

The second form of warfare, that of commerce-destroying, is minor, because difficult to attain without command of the sea, and also by itself generally secondary in results unless in form of blockade. Combined with other operations, it is of course an element making for successful termination of war.

The third form of warfare, territorial attack by combined expeditions, also requires a command of the sea by the vessels of the line of battle, and if the enemy is unable to dispute the command of the sea from want of force, the expedition is minor as a naval movement, because, being combined, it is only naval to a partial extent, and if all naval, it is limited in its reaching effect and possibilities.

Let us now return to the question of preparation, and especially to the formation of plans of organization.

It is not necessary before a professional audience to lay undue stress upon the importance of a proper and complete organization of the naval service, and of the particular forces engaged in operations, both with respect to material and personnel. Of this subject and its kindred one, of mobilization for war, too much can not be said. Mobilization itself should have careful, thorough, and practical treatment; it includes the setting in motion of the material of the "elements of war," which the Germans call *Kriegsmitteln*, and the assembling of the combat forces, or *Streitkräfte*. There is no one subject that can better occupy the officers who are connected with this College than the discussion and evolution of such schemes, to be finally presented in a cogent shape to those busy men who administer the various bureaus and offices which compose what we know as the Navy Department.

The subject of this lecture will not, however, include these questions of organization and mobilization, important as they are, but will deal with the subjects that follow—of Preparation for War generally, and, more particularly, of the elements to be considered in the formation and execution of plans of naval operations.

Plans for rapid and systematic mobilization have, however, been formulated and, to an extent, put in operation at the present day for the armies and navies of the principal European powers, and hence the events which precede and follow the actual outbreak of war progress too quickly to allow time for a general or special reconnoissance of the theater of operations either at home or abroad. Hence this reconnoissance, that formerly took place in time of war, should be made now in these times of peace. This is particularly the case with naval warfare; for to the existence of men and vessels in reserve and the powers of rapid assemblage are added the greatly enhanced qualities of speed and sea endurance. These properties give to naval operations such a possibility of quickness and vigor in the execution, as well as increased length of reach, that the time permitted for the preparation for counter attack or defense is correspondingly shortened.

A thorough acquaintance with these matters is of essential importance in the preparation for war, for, no matter who takes the initiative, we should be fully aware of the length of time it takes us to assemble and concentrate our forces upon given points either at home or abroad. Actual practice alone will give us this, and if squadrons were habitually kept together, a long step toward preparation and actual readiness would be made.

Of equal importance is the knowledge of the time required by possible enemies to mobilize and concentrate their force or forces at any one or more of their principal ports. This knowledge should, if it is within the bounds of possibility, be sufficiently accurate and definite to establish, within the limits of a day, the time required for the assembly ready for distant service.

Besides the very short time at our disposition upon the eve of war for military and naval preparation, it must be remembered that the postponement of the time of preparation until this period is objectionable in other respects. Measures taken during such a time, a time of emergency and great popular excitement, will naturally be imperfect, ill-digested, and extravagant, the conditions being particularly unfavorable to deliberateration and good judgment.

As a matter of good government policy, such preparations made upon the eve of a threatened outbreak are undersirable, being unfavorable to a reasonable diplomatic settlement of delicate questions, and also to the maintenance at home of a calm frame of mind. There are, of course, certain lines of policy which may be followed which require and create elaborate and more or less theatrical preparation for war, but this is not a matter pertaining to the naval or military policy of a country, but may be put more particularly within the domain of state policy of a certain kind.

The sudden nature of war is historical. This suddenness has been shown in a cogent manner not long since by a publication made by the intelligence branch of the quartermaster general's office of the British army. In this little work a historical abstract has been made covering a period of years from 1700 to 1890, one hundred and seventy-one years in all. During this period one hundred and seventeen cases of hostilities have occurred in the civilized world, one hundred and seven of which have been commenced either by subjects of European powers or citizens of the United States without due declaration of war. In forty-one of these cases the manifest motive was to secure an advantage over the enemy by the suddenness of the movement and the consequent surprise to an unprepared foe. Even with the United States, whose Constitution vests such declaration in Congress, the specific terms of its declarations have been that a "state of war actually exists" between the United States and such and such a power, acknowledging by its very declaration the existence of preceding acts of hostilities and war. Do not let, then, any person in civil or military life feel unduly apprehensive that the preparatory work at this or similar institutions will lead to overmuch and dangerous readiness for war. We can not ignore the teachings of our own history, even to the most recent day, and the traditional and habitual want of preparation of the United States for war. We may easily rest assured that with our susceptible and certainly high spirited people, more or less given to excitement, and fully conscious, in civil life at least, of our great national wealth and unworked strength, that we will ever exceed in the possibilities for war any and all preparation.

Let us come, then, to the subject of preparation for war as narrowed down in the last grouping. We mean this to include, then, a preliminary study, made in times of profound peace, of the probable theaters of operations, both at home upon our own coasts and waters and abroad, and also a preliminary study of our own resources for offense and defense and those of our possible enemies.

These studies should be broad and general in their scope, but based upon accurate information; and when we narrow our range to a particular field or plan of operations, a closer and more detailed examination should follow of the designated field, making use of the most recent and accurate information.

As a part of the wider and more general study incident to the preparation for war should come the examination of campaigns and naval wars that are a matter of history. The necessary preparation for war, so far as it relates to the formation of plans of operations, may be said to be capable of division under three distinct heads:

1. The historical.
2. The geographical.
3. The statistical.

First, as to the historical. There is a prejudice existing against the study of past naval and military history which has been referred to in the case of naval history by a late president of this institution, Captain Mahan, in a former address. Repetitions and restatements are always permissible, if not necessary, in spoken lectures, so before discussing the use of historical examination in its narrow sense, let me digress for a moment and speak of its value in the broader sense.

Naval history has been termed both obsolete and theoretical. The tools of war may be obsolete, but the lessons to be learned from history are still valuable, and instead of being "theory," history is, on the contrary, the crystallised experience of others.

An English writer has illustrated the attitude of many toward historical study in so practical a manner that I will venture to repeat it. He refers to what easily may be an actual case: An officer of experience and rank, fresh from distinguished service in the field of battle, appears before men of his profession and relates his story of the campaign or of the action in which he was a participant; it is well received, called practical, the real thing, etc. The same officer reduces his narrative to writing, corrects errors, verifies statements, prunes extravagances, etc., and prints it. Is it still less practical? Does it become theory?

A German officer, in discussing the question of the study of military history as a means of increasing the military capacity of an officer, points out that no personal acquaintance with European or other warfare can compensate for a lack of knowledge of the larger experience of the past which may be derived from a careful study of what has happened to others.

He calls attention to the fact that every man's experience is confined to the narrow circle of his own activity, which activity is most likely to be exercised in a different position and sphere in every new war in which he is engaged. "Even within the same limited sphere," he says, "personal experiences of war differ entirely one from another; one man has only been present at successful actions; another only at defeat: a third has never been under fire at all. One was in the advanced guard which was struggling with all its forces to win the day, while another only arrived at the battlefield when the enemy's strength was almost broken."

In the study of naval or military history the first object to be attained is to acquaint one's self with the exact facts ; and these facts, which are not always grouped systematically or completely by writers, should be mastered in the following general order : First, a knowledge of the cause of the war ; second, the mastering of the description of the theater of operations—this is not always given, either by text or map, but maps should always be referred to ; third, the strength of the belligerent forces should be known and a due comparison made ; and finally, the plans of the opposing leaders.

By such an analysis of the history or histories of certain campaigns or wars we acquire the salient matter preliminary to following the course of actual operations. This acquisition made, it becomes in order to trace and ascertain, so far as we can do so and so far as history shows it, the events in their relations as cause and effect. By this method we will have very often—possibly in most cases—to refer to more than one commentary, but in an exhaustive study of naval and military history much chaff must be gone through with to get at the kernels of wheat.

The examination of the course of the campaigns is continued and concluded by an endeavor to form a judgment as to the fitness and completeness of the means employed to the ends desired.

In a narrower sense a historical examination of the probable theaters of war, or a possible field of operations, should be made, in order to learn by history the elements that may again enter into operations covering a similar area. Some points are historically strategical, successive wars showing that operations are naturally based upon them, or that they are for political or military reasons objectives of campaigns.

The islands and waters of the West Indies have become well known to the students of military and, more especially, naval history. The future is teeming with great possibilities of a similar kind in the same area. Brest, Portsmouth in England, the Straits of Gibraltar, the Gulf of Lyons and Genoa, the Grecian Archigelago, the waters about Sardinia and Corsica, the Mediterranean coast of Egypt, and the English Channel are likely in the future to be as rich in military and naval associations as in the past.

Even within our own borders, limited as our naval and military history has been, there are points that history has shown to be strategical. Halifax, the Canadian border near Niagara, both lake and land, the vicinity of the capes of the Chesapeake, Ship Island and its neighboring waters, the Mississippi River, Bermuda, and Jamaica are as likely to be used for offensive operations against our waters and cities in the future as in the past.

The historical examination being made made, we should then enter into the geographical study of the features of the particular area under examination. The geographical study of an area is as important to naval operations as it is to land operations. Charts, both general and special, are as necessary to naval campaigns as maps to military movements. Fortunately we share with the rest of the world in the possibility of securing charts, carefully and deliberately made for purposes of navigation in time of peace, that comprise all navigable seas and waters. Von Moltke well says that geography is three-fourths the science of war.

The geographical study of a given field of naval operations is, then, to a great extent the question of distances and a hydrographical study of the waters and coasts of that area. It means a careful scrutiny of the charts of these waters with a view to their safe and free navigation by the largest as well as the smallest vessels likely to be incorporated into a naval force operating there; and also an inquiry into the nautical conditions by sailing directions, as well as charts and other means, of the various bays, harbors, roadsteads, and anchorages, with a view to their entrance and uses for refuge in bad weather, as well as for their natural facilities for coaling, repair, refit, blockade, or for landing operations. A further examination should be made, from a more purely military standpoint, of the availability of certain harbors and anchorages for temporary or permanent defenses, on shore and afloat, and also the value of these anchorages as points from which temporary or prolonged offensive operations may be based, either by vessels of large size, by fleets, or by smaller craft, such as topedo boats. This brings into consideration the availability and desirability of certain of the harbors for use as future naval stations and their defensibility, and includes, besides, their local conditions, their relations toward other waters, toward other ports, and toward centers of population. With this examination will go an inquiry as to the resources and topography of the tributary country, as to the inland communications by water and by road and by railways, and also as to the positions of these harbors in relation to the avenues of trade and the commerce of the seas. In other words, this examination means a study of the elements which, combined, give strategical value and importance to any place, body of water, or section of country.

The geographical conditions of the strongholds of Canada—Halifax, Quebec, and Esquimalt—show the use and strength of the navy which makes them almost impregnable.

Questions of commercial geography may enter into the study of a given country and of a naval campaign. These may relate to the interference caused by blockade, capture of ports or territory, or commerce destroying, with movements of great staples in such quantities to materially affect the markets and industries of the world. We had an instance of that kind during our civil war, when the blockade of the Southern ports caused a cotton famine throughout the world ; which in turn created a distress in portions of England, made excessive prices everywhere, stimulated production in Egypt and India, furthered adventurous blockade-running and brought to the front, directly and indirectly, political questions that became grave as well as vexatious.

Any offensive operations against certain of our ports or certain of our territory would be likely to repeat the same scarcity of cotton in the world, while operations against some of our Atlantic, Gulf, or Pacific ports would seriously interfere with the world's supply of breadstuffs.

In the same way the blockade or interference with the trade of India or Odessa would affect the supplies of grain, a similar interference with Australian ports would affect the supply of wool, or the great supply of coal for the Pacific emanating from New South Wales.

This distress would not be alone to the consumer, it would be severely felt by the producer. The consumer could turn to other markets or to substitute products, but the producing country having a large population depending for a livelihood upon the production and sale of staples would feel a distress that would become so severe and so general as to affect the progress or conclusion of the war. Even in the turbulent countries of Central America it has been found that peace prevails during the season for gathering the coffee crop, as not only quiet but large bodies of men are needed for picking, preparing, and transportation of the crop to the seaboard.

The serious interference with the supply of coal to a country like California, where coal is only mined in small quantities, of that of provisions to a country wanting in breadstuffs, like that of England, would be an important and, in the latter case, a vital matter. The protection of, or interference with, such movements of staples can readily become a naval matter of the first magnitude. The deprivation of such essential is a legitimate object in war time, however effected.

The statistical side of the preparation for war and for warlike operations bears upon the knowledge attainable of the facilities for war, especially those facilities that are created by man or caused by his existence as a fighting animal. All of these facilities, natural and artificial, must be considered in weighing the military and naval conditions of ports, sections of countries, or nations. They enter into and give value to such ports and points strategically.

There are, however, certain places having limited population that are more or less inaccessible from populated centers, and also without close proximity to means of transportation and communication, that still possess such fine geographical position which, added to good harbors and facilities for defense, make them of great strategical importance. King George's Sound in Australia, and Chiriqui Lagoon (in the event of a canal), in the Caribbean Sea, are places of this nature ; they have few or no artificial facilities.

Statistical information bearing upon the climate, winds, and prevailing weather at various seasons of the countries under discussion are, of course, matters of importance in naval operations.

The sickly and hurricane season in the West Indies ; the northers in the Gulf of Mexico ; the ice at Vladivostok, upon the Great Lakes, at Louisburg, in the St. Lawrence are and were matters determining times of military and naval operations. These are mentioned here, however, more in the way of enumeration, for it is hardly necessary to speak of the importance of climate, for instance, in its bearing upon the personnel of a naval force, dictating not only the season and time for operations, but also requiring a consideration of the amount of human exertion possible, as well as other matters of precautionary hygiene.

The Santiago campaign, with its sad and demoralizing loss of life at the end on shore, is an evidence of the great importance of this matter.

Of the strictly statistical matters to which attention will necessarily and at once be directed, the foremost are those giving a knowledge of the forces and resources of the possible enemy. With this knowledge is included complete and detailed information of the organization and distribution of these forces, both habitually and at the moment, as well as their discipline and condition and the spirit actuating them. At the present time, on account of the wide publicity given such matters through various military and naval publications, and also by means of the various intelligence departments of different countries, this is a much easier task than in years gone by.

There is rather a disposition now to parade military and, more particularly, naval matter and resources.

No country does this more than our own. (I suppose to an extent newly-laid eggs must have their cackling accompaniment; they certainly get it with us).

The duty of acquiring this information is done with us by the Office of Naval Intelligence, with which this College and its permanent staff should have the closest relationship.

The general staff of the German army, at Berlin, was the first to inaugurate this system of gathering intelligence. It contains three sections, especially charged with attentively following all military movements, both at home and abroad, for the purpose of keeping themselves informed concerning everything touching organization, recruitment, armament, equipment, the geographical configuration of the neighboring countries, in the construction and demolition of fortresses and the development of ordinary roads, railroads, canals, etc. This is in addition to other duties not now necessary to mention.

The countries of the world are distributed among these three sections, and form the subjects of special study. This office of the general staff at Berlin, and its workings, has been copied more or less closely by every naval and military power of consequence in the civilized world.

Besides the finished naval resources, a current knowledge of the raw or unworked naval resources is important. Although I am distinctly opposed to relying upon improvised naval material, the habitual absence of continuous constructional policy and foresight with us forbids a neglect of the possibilities and of the elements existing in that way that could be utilized. In addition to these material resources that are more or less elements of war, there are some more elements that should be well known, both as to ourselves and to others. I refer to such matters as the number, quality, and spirit of the arms bearing population: the quantity, quality, and proximity of the coal supply; the best way of transporting it to vessels by land and sea; facilities for docking and for repairs to vessels and machinery; means for transporting, by sea and overland, men and supplies; means of communication and concentration, and a thousand other matters of more or less importance. These should be well known to the Office of Naval Intelligence and be within easy reach of those charged with formulating or suggesting plans of operations.

Having made a study of the theater of operations in its historical, geographical, and statistical aspects, ideas should be formed and formulated of the relative strategical value and importance of the principal points. By strategical points I mean those positions the control or occupation of which, in the field of operations, adds to the power for warlike action of a fleet or army.

These points in our possession form bases of operations, in the possession of the enemy they should form our objectives. They are, however, but territorial objectives; the primary objective of any naval campaign being the enemy's force or fleet; if he has more than one, his principal one.

By the defeat of this fleet or force the command of the sea will be secured, and we will then be at liberty to make a territorial attack of any kind; for it is worse than useless to prepare for such a movement unless the fleet is first disposed of.

In the late war the termination was due to the loss of sea power by Spain. With colonies insular in character, and separated by sea from the mother country, the hopeless inability to command the sea, shown after the defeat of Cervera's fleet, preceded as it was by the destruction of the Manila fleet, made the loss of these colonies only a question of time. Undoubtedly much loss of life and material could have been inflicted by the continuance of the war, but the results were inevitable. Neither supplies nor re-enforcements could be furnished from Spain, while military and other supplies, as well as re-enforcements, could be poured in steady streams from the Atlantic and Pacific coasts of the United States by seas over which our forces had complete command.

When the sea power of Spain, then, was hopelessly lost, Cuba, like ripe fruit on a tree, fell as such fruit would fall, with a single but necessary shake. That shake was the attack and capture of the town, harbor, and defending force of Santiago by the land force of the United States.

Modern teaching of military movements on shore is to the same effect, though it is possibly less essential in army than in naval movements, the movements of fleets and naval forces being vastly more free and rapid than those of land forces, the legs of the fleet being mechanical and the sea full of roads and pathways leading in all directions. Von Moltke, in ordering the offensive at the outbreak of the Franco-German war in 1870, worded his orders to the 3rd army to the effect that when re-enforced by the Baden and Wurtemburg divisions it should advance to the south by the left bank of the Rhine to seek and attack the enemy, closing by saying: "In this way the construction of bridges to the south of Lautenburg will be prevented and the whole of south Germay protected in the most effective manner."

Grant, in discussing the movements upon Richmond, stated that Lee's army was his objective, rather than Richmond or its vicinity.

With the command of the sea in our possession, either by the absence or defeat of the enemy's forces, a freedom to attack territory will be ours, which territorial objective can be the principal fortified port, the principal mercantile port, or the capital of the country, or a port which combines the three in one.

The formation of any plan of operations in time of peace should not, of course, be rigid, but tentative in its nature, with a breadth of sphere and an elasticity that will allow for varying conditions.

For instance, the numerical strength of the land and naval forces, their readiness for war, their expeditionary possibilities, and finally, their distribution at the time of the outbreak, vary from time to time.

The plans of mobilization and concentration should be peace problems. The arsenals for outfit, or rather the particular navy yards, should be matters of previous determination in peace time, the selection of advanced bases and coaling points being made upon the eve or outbreak of war, from information well digested and collected in peace time.

Our naval operations during the civil war brought out the special necessity for some of the matters just mentioned. One was the necessity of having bases of operations and supplies close to the objectives and areas of operations, whether operations were in the nature of attacks or blockades.

The use of Hampton Roads, the capture of Port Royal, the use and possession of Key West, Ship Island anchorage, and afterwards Pensacola, gave our naval forces important and even essential points, and when New Orleans fell its useful facilities and valuable position made it the important point for the Lower Mississippi and neighboring waters. The value of Guantanamo with respect to Santiago, or Key West with Havana, in the war with Spain, is too recent to require more than mention.

These points, except perhaps Hampton Roads, were in the nature of secondary bases, in close proximity to the fields of operations.

Another object lesson of our great civil war, not always appreciated to its full extent and in its vital effect upon the final result of the war, was the great value of the command of the sea which we enjoyed during the war. The raids of the *Alabama* in the Gulf, and of the *Florida*, *Tallahassee*, and *Tacony* upon the Atlantic, only emphasized, by the momentary disturbance and confusion they created, the exceptional nature of such interruption and the completeness of the control of the sea by the Federal Navy.

The lines of communication and supply extended from the extreme Southwest to the North Atlantic ports, and they were free and unrestricted highways, while the Northern coasts and ports remained, during the war, almost unprovided with defensive measures. Streams of vessels passed North and South, carrying bodies of men of both services and military supplies of all kinds as a rule without convoy and without disturbance. As a result of this freedom our opportunities for naval and military operations against the maritime frontiers of the enemy's country were unrestricted, and the blockade was carried on effectively against a country which depended upon its agricultural products almost entirely for the procuring of other necessary supplies by means of its commercial relations with the outside world.

The weakness of a maritime frontier was exemplified in this war. Here it was plainly shown that the safety of such a frontier is not given by the sea which encircles it, but depends upon the skill and power of its defending naval forces. Its very accessibility is its weakness.

In estimating the times and distances possible for naval vessels it must be borne in mind that the speed of vessels is diminished by combination. The single commerce destroyer and the single torpedo boat represent the highest speed, diminishing with the squadron of unarmored vessels, and still more for a squadron of battle ships, the average speed of which for making long passages will rarely reach 12 knots. The speed of a convoy of transports or freight steamers is the slowest of all.

In discussing the opening of operations, we find that the question of taking the offensive or defensive is to a great extent a question determined by the circumstances of the relative strength of force and readiness. Even when the defensive is forced upon us by the general policy of the war, offensive movements in individual instances and operations are preferable.

Von Der Goltz well says: "It is only by the offensive that the object of all warfare can be realized—the destruction of the enemy's army. * * * The defender does not make war, he submits to it. To make war is to attack."

It must be remembered, however, that we are dealing with this question as one of strategical movements, not of battle tactics or action.

While the question of the assumption of the offensive or defensive is almost entirely dependent upon the circumstances at the time of an outbreak of war, it, however, may not be out of place to give the advantage ascribed by military writers to both.

It has been said that the power of an armed force consists both of moral and material strength.

As to moral strength, it is at its best in offensive movements. Such movements give confidence to rank and file. To the general officers directing an offensive movement it has the great advantage of presenting a definite and tangible end. The adversary, upon the other hand, is in the dark. At best he can only surmise, unless he has definite information, and concerning the absolute certainty of this he can never feel sure. The defensive, it can be seen, here occupies a secondary rôle, necessarily subordinate to the movements and maneuvers of the attack.

We are very apt to gain in taking the initiative, either by surprise or energy, or both, a partial success. This superiority, great or little, once gained at the opening of a campaign, has its moral effect both upon the forces actively employed and the people sustaining them at home. Every incentive is thus given for its maintenance to the end of the campaign.

Manifestly the superiority in large movements at sea and afloat in a moral sense is with the offensive. This does not mean an attack of insufficient force upon strongly defended positions. Here the force that is equal to the attack must be much greater than the force defending, as defensive facilities have outgrown the attacking facilities on shore. Take an armored turret, for example, ten men inside, and twenty outside attacking. The moral advantage here is with the defensive. In an attack upon forts or batteries defending harbors the defensive facilities have relatively gained upon attacking facilities. Vertical and plunging fire, disappearing batteries, and submarine mines have gained, in my mind, upon ships alone, whose prescribed pathways and approaches are here made fixed and rigid by channel limitations.

As to the strategical advantages of the defensive, they are :

1. The knowledge of the countries and waters in which we operate. We control, also, as well as know, the country with its resources, and are familar with the climate and other natural conditions.

2. Morally we have the powerful consideration of a defense of our dignity, our homes, and our country ; of not making war, but only repelling it.

To a certain extent the creation of proper offensive facilities does not rest with those of our profession, but certainly a knowledge of our defensive possibilities is within our reach ; this includes a thorough familiarity with our maritime frontiers, the strategic features of our coasts, and of our resources and capacities. If any strong naval power were at war with the United States, with the Navy we have or are likely to have within the next ten years, our policy would have to be a defensive one in its general scope, though it could be offensive in the execution of this defensive so far as it is practicable—in other words, the offensive-defensive.

The attacks upon the enemy's naval force would be made when his forces came within the zone of our maritime frontier, taking any and every shape that the circumstances and war resources would permit. We would, as mentioned before, have certain advantages resulting from the knowledge of our waters and territory. We would have ample supplies and a dense population, whose centers would be closely connected with each other and with the seaboard. The business of supply and transportation, with our genius in that way, would probably be well done after a time. If we succeed, and a command of the sea along our own coasts be secured, the sphere of the offensive-defensive would not be unduly exceeded by the undertaking of counter attacks upon the adjacent bases of operations of the enemy. Our enemy in the case under discussion being necessarily a European power, these counter attacks would most likely involve operations against the coaling or naval stations in his American colonies. There are a number about us : Halifax, Bermuda, Jamaica, Barbadoes, Port Castries, Esquimalt, or Vancouver, for example, for the British. These attacks could be made by a maritime expedition of combined forces.

The French have near us Martinique and Guadeloupe, and, to a much less degree, St. Pierre and Miquelon.

Let it be borne in mind, however, that the teaching of history is that, as a rule, serious operations by sea against an enemy's ports are practicable only to the naval powers that hold and can retain the command of the sea.

The ports in the world from which modern squadrons and fleets of any size fit out and sail are limited in number and well known. The variety and technical nature of the supplies of a modern fleet, the size and depth required for harbors by large armored vessels, and the coaling, hoisting, and docking facilities demanded, limit the ports available in any one country to a very few.

These ports should be watched upon the outbreak of a war by cruisers, and, if possible, masked by a naval force of sufficient strength. It has been the policy of England to do this with France, and with any other power the policy would doubtless be the same. England has done this in the past even upon the approach of possibilities of war without waiting for the outbreak, masking often individual vessels.

In dealing in this and other lectures with coast defense, I wish to convey clearly the idea of coast defense and not harbor defense. Coast defense is a very much used term, especially by our brethren of the Army when defense of a harbor or port is meant. Both have their value; harbor defense successfully carried out continues the possession of the port in our hands; coast defense provides for its freedom of trade movements, the continuance of its utility, and the vitality of all that pertains and depends upon it as a port.

Harbor defense is entirely military in its character or mixed military and naval. By a successful defense of this kind the enemy is denied the occupation and use of the port, which includes its facilities, both artificial and natural, while the property existing, both public and private, is preserved from destruction and injury. But this may be the case, and still, by blockade or outside command of the sea, the use of the port may be suspended or paralyzed.

Trade and commerce may be stopped—the very things that have called into existence the port and gave to it life, activity, and prosperity, as well as indirectly to all the country of which it is the outlet. The prevention of this paralysis is the function of coast defense, properly so called; this coast and outer defense can only be made by the naval forces of the country.

It is true, during the Napoleonic wars, the French had a system of coast batteries, permanent and moveable, which prevented the landing of an enemy and allowed, to an extent, communication by sea between the coast ports; but this was for military purposes only, and ended with the range of their guns and did not permit the general use of their ports or remove the British forces off the coast of France or outside of the zone of their maritime frontier.

Organization having been completed, preparation finished, the plan of operations and its nature decided upon, next comes—action. The Emperor Napoleon once said that when he formed a military plan there was no man more cowardly than himself. He exaggerated all the dangers and imagined all the evils possible under the circumstances.

But when the time came for puttiing in execution his plan, his watchword was Audacity! Audacity! Audacity!

The conduct of war as a whole has been compared to the action of a complicated machine, whose friction is extraordinary. The combinations which are so easy to project upon paper can only be put into rapid execution by the greatest effort.

In order, then, to attain successful and certain results, it is necessary to put into operation all of the forces at our disposal, even to their extreme limit of tension. All means of action should be concentrated upon the decisive point, and, above all, no time should be lost. It has been well said that "rapidity of movement kills in their germs a crowd of measures which the enemy would have taken." This was one of the secrets of Stonewall Jackson's success during the civil war.

Surprise due to promptness of action plays a part much more considerable in strategy than in tactics. Napoleon, Frederick the Great, Cæsar, Hannibal, and Alexander owe to rapidly much of their brilliant success and great fame. He who strikes quickly strikes twice.

Let me now close with a quotation from a work by Colonel Maurice, of the English army, in which he aptly says:

"There is no royal road to the knowledge of the art of handling armies, any more than to any other branch of human activity. All that the best summary on that subject can profess to do for a reader is to assist him in undertaking a methodic study for himself of the principles which have guided great commanders; of the experiences of those who have fought in great battles and great campaigns; in endeavoring to put himself in their place so as to see with their eyes, hear with their ears, and realize the passions which influenced them, and the circumstances under which their decisions had to be formed.

"The historical student has at least one advantage which is always and absolutely denied to the general. He may never, for many reasons, have an altogether correct and completely true picture of all the circumstances which occurred on a given day, but he has a far more complete one than could possibly be before the general at the moment when he formed his decisions.

"Still more, he has far better materials for judgment than any one of the minor actors who had themselves to decide what they ought to do, within the limitations of the orders they received, on most incomplete knowledge of what others were doing at distant parts of the field; of the positions and designs of the enemy, and of many other facts which may now be known with certainty by anyone who will read what happened.

"Then he will perhaps perceive that, after all, the question whether he would himself have given the right decision, no matter what his previous training may have been, will be more a question of character than of knowledge. Nevertheless, he is much more likely to decide aright if he has in mind some larger knowledge of the accumulated experience of the past than if, without anything to guide him, he judges by a so-called common sense which has already led him to ignore the earnest advice of those who have been themselves most successful in war."

SIEGE ARTILLERY.*

By Captain G. N. WHISTLER, 5th Artillery.

Upon the declaration of war with Spain the service was entirely without any organized siege artillery. No siege train or batteries had been maintained, nor had any modern siege guns been issued to the troops for practice or drill.

In the olden days each artillery post had at least a battery of siege guns, generally consisting of guns, howitzers and mortars, with the proper complement of platforms, mortar wagons and implements for mechanical maneuver.

All the heavy batteries in the service had more or less instruction and practice with this armament.

After these guns became obsolete and the carriages useless the Ordnance Department constructed a number of siege guns and mortars after the most approved foreign models, and only lately completed six 7-inch siege mortars and beds.

These guns were never issued to troops, and the artillery had had no experience with this armament and no practice with the guns.

Soon after the declaration of War General John I. Rodgers began the organization of a siege train at Tampa, Florida, for service in Cuba.

It is not my purpose in this paper to attempt anything like a history of the work done at Camp Rodgers, nor to attempt to set forth the magnitude of the undertaking to organize an efficient siege train at the breaking out of a war.

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* HEADQUARTERS DEPARTMENT OF THE EAST,
Governor's island, New York City,
August 7, 1899.

Captain G. N. Whistler,
5th Artillery,
Fort Wadsworth, N. Y.

Sir :

I am directed by the Major-General commanding to inform you that your yceum essay, entitled "Siege Artillery," being esteemed especially valuable, has been forwarded to the Adjutant-General of the Army, with a view to its usefulness to the Division of Military Information.

You are authorized, if you so desire, to publish the essay.

Very respectfully,

T. Bentley Mott,
1st Lieutenant, 7th Artillery,
Aide-de-Camp.

Four batteries of artillery that had had no experience with modern siege artillery, most of whom had never seen a modern siege gun, were assembled at Camp Rodgers, Tampa, Florida. The greatest strength of any battery was sixty men. This number was increased within about thirty days to 200, giving each organization about 140 perfectly green recruits. Two of these batteries were soon ordered to Cuba, leaving two batteries ("M" and "K," 5th Artillery), to organize, assemble and prepare this train for foreign service. To train green horses, drill and instruct perfectly raw recruits in the duties of a soldier, infantry drill and riding, and to teach green horses to work together in the hands of green drivers. In addition to this, ammunition had to be prepared, shells to be filled, and the entire train prepared for service in Cuba.

Soon afterward several more batteries joined the train, which were recruited to the maximum strength, and amid the sweltering sun of Tampa's deadly shore and the daily rain of the summer season a work was carried on, the magnitude of which can hardly be conceived by those who did not take part therein.

Drilling and training green troops, caring for and instructing green horses who were utterly unable to stand the climate, unloading and loading guns and carriages without even the ordinary implements for mechanical maneuver, and, "last but not least," fighting disease.

My object is, however, to discuss the question of siege artillery from an entirely different point of view, and I refer to this experience, primarily, as I shall find it necessary to refer to my experience in that camp, and, secondly, to tell my brother officers that the artillery had nothing to be ashamed of in the work done by the siege train during the Spanish War.

Siege artillery is intended for the attack and defense of fortified positions. Formerly what was ordinarily termed siege artillery consisted of guns or howitzers mounted upon wheeled carriages and mortars carried upon mortar wagons, but whenever possible garrison guns which were fired from stationary mounts have always been used for siege purposes.

In defensive work, where ample time could be had, such guns were used in the most important positions. In modern sieges such guns have been used in the attack as well as for the defense, particularly where railroad transportation was possible. Thus General Abbot transported and used 100 pounder Parrotts with great success, and in the siege of Charleston 200 pounder Parrotts were used.

In England, where great attention is paid to siege artillery, heavy guns are made a part of the siege train. Guns of 5 and 6-inch calibre have been manufactured and mounted upon hydropneumatic disappearing carriages for siege purposes. Such guns are transported upon wheeled carriages, the mount being transported upon a suitable truck, and are intended to be mounted and used for attack and defense where the time is sufficient to put them in position.

Generally speaking, modern siege artillery may be divided into two classes: 1st, siege guns proper, mounted upon wheeled carriages, both for purposes of transportation and for use; that is, they are fired from the carriage upon which they are transported; 2d, siege guns of position, which are not fired from the carriages upon which they are transported. I do not intend to discuss the general use of siege artillery, which should be well understood by all artillery officers, but merely to discuss the conditions which have been produced by the introduction of the modern high-powered gun, of which our officers know very little.

It will probably be well to begin by comparing the present siege armament with that with which most of our officers are familiar.

The 4.5-inch siege gun weighed 2570 lbs.; gun, carriage and limber complete, 7400 lbs.; weight of solid shot, 35.5 lbs.; muzzle velocity, 1280 ft. sec.

This gun was fired from a platform which weighed 2579 lbs., without any extraneous means of taking up recoil.

The momentum of the carriage when the shot left the bore was practically 45,440 ft. lbs.

The modern 5-inch siege gun weighs 3660 lbs. I do not know the exact weight of the carriage, but the entire weight of gun, carriage and limber is somewhere about 7300 lbs. This gun fires a 45-lb. shell with a velocity of 1830 ft. sec. Momentum of gun and carriage at instant of recoil, about 84,000 ft. lbs., or nearly double that of the old 4.5-inch gun.

The old 8-inch siege howitzer weighed 2600 lbs.; with carriage complete, 6660 pounds, and fired a shell weighing 45 lbs., with about 1000 ft. sec. velocity.

The new 7-inch howitzer weighs 3700 lbs.; the carriage complete, about the same as the gun, or possibly slightly more; and fires a shell weighing 105 lbs. with a velocity of 1085 ft. sec, thus producing double the momentum of recoil.

To take up this enormous recoil it is necessary to attach the carriage to the platform by means of an hydraulic cylinder and pintle. The platform weighs 5600 lbs. This platform must have a good hold in the ground, and the time required to prepare the ground and assemble one of these platforms is about five hours in any solid soil.

When we consider that the ammunition for the modern gun weighs double that of the old gun, and the weight of the platform is also double, it is manifest that the problem of mobility is very different from that of the old siege artillery service.

The 5-inch siege gun, 7-inch siege howitzer and the 7-inch siege mortar are the only siege artillery proposed for our service.

These pieces can only be fired from their platform, and it requires time and work to bring them into position.

For defensive positions and for the more important positions in an attack this armament is all that could be desired. There is, however, work for siege artillery which, in my opinion, requires a lighter armament.

In a regular set siege, after the first parallel has been established and the main siege artillery has been placed in position, the advance by regular approaches begins. Upon the first parallel the heavy guns are placed upon the flanks and the lighter ones along the line, both for use, and in preparation to be advanced through the boyaux as soon as the next parallel is ready, generally during the night. For this purpose we need lighter pieces, which can be fired from light platforms that can be brought up and placed in the prepared positions.

In addition to this we need a bombarding howitzer, which may be fired from a light platform or, in an emergency, without a platform. Such a weapon would be of great value where a regular set siege is not intended, such as at Santiago de Cuba. A shell gun carrying a large bursting charge, capable of being taken wherever a field gun can go, and which can, upon an emergency, be brought into position and fired without a platform, would have been of immense value at Santiago and in Puerto Rico, whereas our present heavy armament would have been almost useless.

In England, where great attention has been paid to the subject of siege artillery, this principle is recognized. They have light siege trains, medium siege trains and heavy siege trains, armed as follows:

Light train, 25-pounder gun, weight 2016 lbs.; 6.3-inch howitzer, weight 2016 lbs.

Medium train, 40-pounder gun, weight 3920 lbs.; 6.6-inch howitzer, weight 4032 lbs.

Heavy train, 40-pounder gun, weight 3920 lbs.; 8-inch howitzer, weight 7840 pounds.

They are experimenting with a 6-inch, 7-inch and 8-inch howitzer. In addition to this they expect to use 5-inch and 6-inch rapid-fire guns, mounted upon fixed mounts, disappearing carriages.

The above-mentioned armament is the old style armament with which the trains are now armed. There has been constructed a 12 cm. B. L. howitzer which weighs 2750 lbs. This gun is serviceable for field, siege or defense; the guns are mounted upon carriages which have a spring recoil and can be fired without platform. The carriage is so constructed that an elevatian of 60 degrees can be obtained. The gun recoils axially in a steel recoil cylinder which envelopes the rear end of the gun. In the account I have, the weight of shell is not given, but is probably about 40 pounds. This gun is a type, and it is the intention to build heavier guns upon the same plan.

For work in mountainous countries they have constructed a jointed gun, in three pieces, each of which weighs 960 lbs. This gun when put together is 9 feet 3 inches long and fires a shell weighing 25 lbs., using a large bursting charge, and a shrapnel weighing 25 lbs., containing 238 heavy bullets. The entire weight of gun and carriage is 5160 lbs. Such a gun would have been of great value at Santiago.

The heaviest gun used for siege purposes is the 6-inch B. L. rifle upon spring carriage, stationary mount. The gun forms a load of 8400 lbs., and the carriage four loads, the heaviest of which is 6480 lbs.

Before entering upon the question as to what should be the siege armament for our own service, I would say a few words upon the subject of the value of shell power, and I feel that I cannot do better than quote from Lloyd and Hadcock's *Artillery, Its Progress and Present Condition*:

"As siege artillery is principally employed for the destruction of a fortified place, it will be evident that the greater the shell power used the greater will be the efficiency of the guns forming the siege train. Indeed, the destructive effect is practically proportional to the bursting charge, or, in other words, to the capacity of the shell, and therefore varies with the cube of the gun's calibre.

"The destructive effect of individual shells, though important, is no criterion of a gun's efficiency. The greatest amount of material damage will be done to any structure in the fewest rounds only when the destructive effect of powerful shell is coupled with accuracy of fire. One shell may do considerable damage, yet not be powerful enough to breach a parapet, but two or three shells planted at or near the same place may easily cut the parapet through.

"As high-angle fire is now generally considered essential, both for the attack and the defense, it follows that for ordinary ranges (*i. e.*, under 300c yards), the initial velocity of the piece must be low. A howitzer is consequently the most suitable weapon for use in this respect, and it is also (being shorter) more easily sheltered under cover. It has been found by actual experiment that with an 8-inch shell, having a striking velocity of 500 f. s. only, a large amount of earth is displaced, the shell penetrating with delay action fuse some 13 or 14 feet before bursting, while with a striking velocity of from 800 f. s. to 900 f. s. an ordinary earth parapet can be breached in about nine effective rounds.

"This number depends much on the exterior slope and the material of which it is composed.

"At short ranges, with guns having a high velocity, there is always a tendency, on account of the small angle of descent, for the shell to deflect upwards after striking, especially where there is a gentle exterior slope, as in the glacis of any fortified place. In this case, should there be any delay in the action of the fuse, the shell bursts in the air after graze, and so little or no damage is occasioned.

"At long ranges howitzer fire becomes more or less inaccurate, and powerful guns are employed instead on account of their superior accuracy; and as at long ranges the angle of descent becomes considerable, there is less tendency for the shell to deflect up out of the earth after striking.

"High capacity, steel common shell should always be used when the striking velocity is high, such as the velocities produced at short ranges with high-velocity guns, as it is found that cast-iron shells nearly all break up on striking, and little or no damage is effected."

In England 60 per cent. of all the siege pieces are howitzers.

The work of siege artillery may be divided into two classes of fire, viz.: breaching and bombarding. For breaching a carefully sustained, accurate fire is essential ; in the case of bombarding which is intended to render the works untenable such great accuracy is not necessary. In bombarding we may use common shell, when the purpose is to disable guns or to destroy interior constructions, or shrapnel when the fire is intended to drive out the troops of the enemy.

From which we may conclude that in the first parallel, especially in the flank batteries, heavy guns should be placed, intended for concentrated action for breaching purposes. In this line howitzers may be advantageous for bombarding, and light as well as heavy howitzers may be used for this purpose. As the approaches advance the heavy howitzers are placed in position for breaching, to act in unison with the guns, the lighter guns being still used for bombarding purposes.

Finally, the lighter guns and howitzers may all be brought into play for breaching.

Light howitzers will, in my opinion, be of great use, even when a set siege is not intended, to act in conjunction with field guns to silence the enemy's batteries by shell fire ; and light guns having high velocity may also be used in a similar manner with shrapnel fire.

So far I have not touched upon the use of a still heavier class of siege guns, and that is the high-powered guns already mentioned, which are to be fired from fixed mounts. It must be manifest, however, that, when time suffices, such guns should always be brought up if possible, and that provisions should be made for such siege armament.

I have also ignored the use of mortars, that is, the mortars such as we have in our service. The siege mortar can play but little part in breaching, in consequence of lack of accuracy ; their value is therefore purely for bombarding.

The above considerations have led me to the conclusion that we need in our service three classes of siege artillery :

The Light Siege Train—Armed with a 4-inch gun and a 5.7-inch howitzer.

The Medium Siege Train—Armed with our present 5-inch gun and 7-inch howitzer.

The Heavy Siege Train—Armed with a 5-inch and 6-inch high-powered gun to be fired from a fixed point.

There might be included in the light siege train several batteries of 7-inch mortars.

The 4-inch gun would weigh 1875 lbs. and use a 25-lb. shell and shrapnel; muzzle velocity, 1850 f. s. This gun could readily be fired from the ground without platform, although a light platform should be used whenever time permits.

This gun, either for shrapnel or shell, would be a very efficient adjunct to field artillery. While it could not instantly go into action, it could readily be brought into position in a short time. The gun should be mounted upon an old-style carriage (by this I mean embrasure system). I think a steel shield could be carried upon the platform wagon, sufficient to cover the gunners when used in the field. In the trenches it would have the usual cover. If it was desired to use it over banks, the gun platform could be raised and the shield used to cover men at breech. The ammunition for this gun should be carried in caissons.

The 5.7-inch howitzer would weigh 2003 lbs. and fire a 60-lb. shell or shrapnel: bursting charge, 6 lbs. of black powder; muzzle velocity, 1000 f. s.

This gun could be fired from a light platform with service charge and, without platform with reduced charges. I think there would be no difficulty in constructing a carriage for this gun, which would admit of 45 or 60 degrees elevation with reduced charges. In the trenches a pintle and recoil cylinder should be used.

The light siege pieces should be drawn by eight horses, and the medium pieces by ten horses.

The problem of draft horses is one of importance. The experience of the several officers at Camp Rodgers seemed to favor the fifth chain and spreader system of draft used in ordinary six-mule teams. I cannot say that I was convinced by our experience at that place. That the direct pull on the long trace of field artillery is not necessary for a siege train is unquestionable, but I fear that the breaking of fifth chains will prove a great disadvantage, and I am inclined to think that a modification of the field artillery harness will in the end be found better than the fifth chain system.

Let us now consider the problem of carriages :

Our present carriages are constructed upon what is known as the over-bank system, that is, the trunnions are placed sufficiently high to admit of the guns being fired in barbette instead of through an embrasure. This method gives greater cover for the men and reduces the amount of work in constructing the battery, and has undoubtedly considerable advantage. For the light siege guns, which may be called upon to go into action in the field with merely the cover of a gun pit, this would be a great disadvantage, and I have therefore suggested that the light pieces should be mounted upon old-style (embrasure) carriages, proposing at the same time the use of steel shields, which could also be used to protect the men at the breech when these pieces are placed over-bank in the trenches.

As the platforms for these pieces would be light, such shields could be carried upon the platform wagons.

The construction of the present carriages is such that the pieces cannot be shifted from the traveling trunnions to the firing trunnions, and *vice versa,* without using the gin or a pair of shears, which necessitates removing the gin from gun to gun or placing the guns in succession under the shears. This, of course, takes up much time, and is therefore a disadvantage where celerity is desired. I would therefore suggest that in the case of the light pieces the carriage be so constructed that the use of a gin will not be necessary for this purpose. The plan devised by General Morgan for handling the 4.5-inch siege gun should be carefully studied, and the carriages should be constructed accordingly.

Captain Sage has strongly advocated carrying the gun and howitzer of our present armament upon a separate truck. Four horses could readily draw the carriage and six the gun. It would take no longer to place the gun upon the carriage with a gin than it now does to shift it from the traveling to the firing trunnion beds, and two teams of four and six horses would work much better and could draw more than a single team of eight or ten. I am satisfied that ten horses will be needed for these guns in a heavy country, or on poor roads.

Of course, a special system of transportation will be needed for the heavy batteries, involving gun truck, carriage truck and platform truck.

The transportation of ammunition is a matter of great importance and should be carefully considered. The kind of wagon to be used should be studied out and some system of preparation and packing should be adopted. The supply of ammunition to the batteries and to the main depot of supply in the field is a matter of great importance.

In my opinion this should be entirely in the hands of the artillery.

I desire to propose the following organization, which, however, is purely an idea of mine, that appears to meet the requirements of the service :

Four batteries of artillery to be organized as a battalion of siege artillery, to consist of 1 battery of four guns, 2 batteries of four howitzers each, and an ammunition train to be manned by the fourth battery.

The siege artillery of an army to be organized into three brigades—one brigade of light siege artillery, one brigade of medium siege artillery and one brigade of heavy siege artillery. The strength of these brigades will depend upon the character of the proposed siege.

In addition to the battalion ammunition trains, each brigade should have an ammunition supply train, also manned by artillery troops and commanded by an artillery officer.

At or near some great commercial centre there should be established an artillery depot under command of an artillery officer, where ammunition and other artillery stores should be received from the Ordnance Department and be shipped to the army in the field. The ammunition and artillery stores should be received at the main field depot and there distributed to the brigade supply train. The brigade supply train constitutes the field depot for each brigade and is moved from place to place as may be necessary to keep in touch with the brigade, but does not deliver ammunition to the batteries. The ammunition is brought and delivered to the batteries by the battalion ammunition trains.

The artillery supply officers should have full authority to make contracts for the shipment and transportation of ammunition and artillery supplies.

By this system the supply of ammunition is in the hands of the men most interested in insuring a prompt and efficient delivery.

The Ordnance Department furnishes the ammunition to the depot, and if the supply is not adequate the responsibility is instantly fixed. The material is shipped by artillery officers to the front, whose professional reputation depends upon the results achieved. Each brigade train serves its own brigade and each battalion train its own battalion.

A complete round of ammunition should be packed in a box, shell, fuse and cartridge; the box should be easily opened without the necessity of using screw-driver or axe. Each box should be painted a peculiar color, which will indicate the character of the ammunition contained therein. Each battery commander should be furnished with a pad of requisitions printed upon paper of the color corresponding to the color of the box containing the ammunition for his battery.

When a requisition is received at the train the officer in charge, even if he has all green men, would simply have to direct them to furnish so many boxes of a given color. The gun might be designated by the main color of the box, and shell and shrapnel by bands painted thereon.

In addition to the ammunition trains, each light siege battery should carry with it in caissons at least one day's supply of ammunition.

I would now speak of certain mechanical problems which made themselves manifest during our experience with the siege train.

The carriage may be considered as made up of permanent parts such as are not to be disassembled except for purposes of repair, and removable parts, such as must be removed whenever the gun is dismounted, shifted from the traveling to the firing bed, or prepared for embarkation.

Primarily all bolt-heads or screws should be of not more than two sizes, so that a single double-ended wrench will fit all screws or bolts, and obviate the necessity of carrying a chest full of assorted wrenches and screw-drivers. For removable parts, screws or bolts should not be used if it is possible to avoid it; all unskilled men for some reason find it difficult to catch the thread of a screw or bolt, and there is always danger of stripping the thread and destroying the screw ; therefore all such parts should, where possible, be attached by keys and pins. Parts required to take up the strain of recoil should not be so attached; the strength of the system depends upon the strength of bolts, and if one is destroyed the entire system is weakened.

All pins used should be tapered and chamfered, so that slight differences of size would not render a gun useless because parts are not interchangeable.

The cap squares of the howitzer must necessarily be very securely attached. In our present carriage they are dovetailed into the trunnion bed and fit so close that it is difficult to get them off or on. In such cases the parts should be tapered so as to enter freely until brought up snug, after being entirely inserted. They would then free themselves instantly as soon as moved.

No screw holes should bottom. When the hole goes entirely through it is easy to clean, but when it bottoms it is practically impossible to remove the sand or dirt. As soon as a soldier finds a screw or bolt work hard he instantly wishes to slush it with oil; this washes off the coarser sand, but the grit remains and, coupled with the oil, soon wears away the thread like so much emery dust. No small parts or set screws should be used if it can be avoided. Many men's fingers are all thumbs, and my experience was that searching for small set screws in the sand of Tampa was worse than hunting for a sleeve button which has apparently dropped right in front of your eyes.

Without intending in any way to criticise, I would state that these suggestions are drawn out by actual experience with opposite conditions at Camp Rodgers.

I do not wish to be understood as criticising the Ordnance Department in any way. While some of the conditions might have been avoided, I am satisfied that the main defects in our siege armament were due to conditions over which the Department had no control. The gun and carriage were built after the best foreign models, and the Department is in nowise responsible for lack of funds. or for the fact that no siege artillery has been maintained to try and test the system during time of peace. I believe that the Ordnance Department has done all in its power to give us the best possible armament within the means furnished them, and I do not think that suggestions as to improvements should be made in a critical spirit.

The following additional ideas were suggested to me by our experience : The jacket of the gun should extend to the rear and the breech-block should be countersunk in such a manner that the mechanism of the breech will be entirely protected from a blow when a piece is slung over the side of a vessel or lowered into the hold. The flask should be arranged into a chest in which should be carried sights, trays, implements and everything necessary for serving the pieces. When a gun is landed from a vessel everything should of necessity be found with it that is required for its service. Guns and carriages snould be made sufficiently interchangeable, so that the first gun landed could be instantly mounted on any carriage.

A gun platform will necessarily require at least two wagons to transport it. Platforms should be constructed so that the two halves to be carried on different wagons are the exact counterterpart one of the other. For purposes of foreign service these wagons should be capable of being lifted bodily into the vessel without removing the platform. Each wagon should have its complement of screws, etc., so that any two wagons will contain a complete platform, This will require an additional pintle for each platform. Everything should be so arranged that the first two platforms can accompany the first gun, and any six guns and twelve platforms constitute a complete battery.

We should get rid of the armament chest, and have a rough repair kit to be carried on each platform wagon.

Sponge, rammer, handspikes and water buckets should be attached to the carriage.

Sight seats should be so arranged that they cannot be injured in transportation. I understand that the seats on guns taken to Santiago were so badly injured in embarkation and disembarkation that the sights could not be inserted. A telescopic sight is, in my opinion, essential for siege artillery; my ideas upon this subject may be given somewhat greater force when I say that I do not see that telescopic sights are of any value for sea-coast artillery except for target practice. For breaching purposes, however, the telescope is essential.

My experience at Camp Rodgers taught me that any sea-coast battery can pick up the artillery work of a siege battery very rapidly.

The chief difficulty we had to contend with at Tampa was in training our horses. With green horses in the hands of green drivers, I am of the opinion that it would take at least two months to begin to get into working trim. If we are to have and use siege artillery, some plan must be devised by means of which we can instruct our drivers during the time of peace and have a sufficient number of trained drivers in siege artillery work at the breaking out of war.

Remember this work is very different from training animals for work in an ordinary wagon. In training a six-mile team to drive the work is begun with an empty wagon, the brake being used to control the team. The wagon is then gradually loaded until the team has been taught to handle a full load, whereas in siege artillery the team must be taught to start with a 7000 lb. load behind them. It is true you can start with the carriage alone and then mount the gun, but even then you have a sudden change of 3600 lbs. in the load. The great difficulty was to teach the horses to start together and to work together if a piece became stalled.

Another important problem is the subject of fire control, which necessarily is of immense importance in regular siege work, where concentration of action is so important.

Some plan must be therefore devised by which a school of siege artillery may be established in time of peace upon as economical a basis as possible. I would suggest the following plan for consideration :

I take the siege battalion as a basis; as many of such battalions may be organized as may be deemed proper.

Four siege batteries constitute a siege battalion, to be commanded by a Major. During time of peace only one of the four batteries shall be mounted. While there is maintained but one complement of horses, the battalion will be armed with every class of siege artillery—light, medium and heavy—ammunition and complete equipment.

The batteries will alternate in serving mounted and at the different kinds of guns, the principle being that every man in the battalion shall be instructed in all the duties as a driver and as a cannoneer for each class of armanent. All officers will thus have an opportunity to handle the different kinds of guns and equipment in drill, mechanical maneuver and fire control.

To those officers who are field artillery men and who may be horrified at three or four batteries using the same horses, I would call attention that the condition is very different from that of a field battery. The mounted problem is merely one of draught, and the object is to teach the men to care for their horses and to practice them in dranght on various kinds of roads. You would first instruct your men to ride, and riding drill would undoubtedly be a part of the daily work; after that, however, the mounted drill would simply consist of exercise with the guns on the road. The trained horses should be sold from time to time and green horses be brought to replace them, in order that the men may become used to breaking in new horses, a matter of great importance at the breaking out of war.

The principle drill will be foot drill and instruction at the guns in service, fire control and mechanical maneuvers. In this manner a whole battalion could be maintained at the expense of one light battery, requiring only a full complement of horses to take the field.

Upon this plan each siege battalion, during time of peace, would on being mobilized be a mixed organization so far as armament is concerned, but as each battery has been instructed with all kinds of guns they could easily be arranged as the service may require.

The siege battalion should be stationed where all kinds of target practice are possible—where they can practice in fire control, breaching work and bombarding work. The station should be thoroughly equipped with everything pertaining to siege artillery work.

If two or more such battalions are organized they might be brigaded together at the same station.

A regiment of siege artillery of three battalions could be thus maintained at the expense of three light batteries and nine foot batteries, or but little more than the present cost of maintaining a regiment of artillery.

THE TECHNICAL TRAINING OF OFFICERS IN GARRISON ARTILLERY.

By MAJOR C. P. MARTEL, R. A.

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Although the elementary study of certain sciences, such as electricity, mechanism, chemistry, etc., has been recognized for many years as forming a necessary part of the education of a garrison artillery officer, still the term "technical education" has hardly as yet been adopted in the service. In civil life the definition, by Act of Parliament, of technical education commences thus: "The expression 'technical education' shall mean instruction in the principles of science and art applicable to industries, and in the application of special branches of science and art to specific industries and employments. It shall not include teaching the practice of any trade or industry or employment, but same as aforesaid shall include instruction in the branches of science and art with respect to which grants are for the time being made by the Department of Science and Art, etc."

Although this definition may not be much help in determining in what direction or to what extent an officer must pursue his scientific investigations, one thing is certain, it draws a line of demarcation between technical education (such as might be of use to regimental officers) and ordinary work-shop training (which is necessary for inspectors of ordnance machinery, or armament artificers).

The work of the technical school should aim at and be limited to the teaching and illustration of principles and methods; if it goes beyond this and attempts the mechanical drilling of a student in the various processes, with a view not to attain insight into principles of work, but to gain mechanical skill and dexterity, then it is trenching on the teaching of the practice of a trade.

The subjects which are usually included in a service technical course and the application of them to artillery purposes, may be put shortly as follows:

(a.) *Electricity.*—Applied to position-finding instruments, range dials, telephonic communications, firing gears, night sights, and an ever increasing number of purposes.

(b.) *Mechanism.*—As seen in gun mountings, gears for elevating, traversing, breech closing, etc.

(c.) *The study of steam, gas or oil engines* used in connection with hydraulic machinery and other purposes.

(d.) *Hydraulics* applied to mountings, loading gears, etc.

(e.) *Chemistry and heat,* with reference to powders smokeless or otherwise, service explosives, or in connection with any other of the subjects enumerated, this being a science the application of which is very widely distributed.

(f.) *Optics,* dealing with telescopes for various purposes.

(g.) *Metallurgy,* especially in connection with those metals used in the manufacture of warlike stores.

(h.) An intimate acquaintance with all the principal stores classed under the heading of "Guns," "Carriages" and "Ammunition."

(i.) Other minor subjects of less importance.

As year by year these sciences will be more and more adapted for use in connection with our coast artillery, it will, I think, become evident that there must be two sides to the education of the garrison artillery officer, one "military" and the other "scientific." It is with the scientific side that this essay has to deal, and so I will endeavor to show that it is a necessary part of our education.

If one takes a broad view of the present impetus for technical instruction, one cannot but help feeling that if some similar system were introduced into the garrison artillery, it would have a great influence upon schemes of defense generally, by reason of the many modernizing changes which would take place if all officers were as skilled in the scientific branches of their work as they are in the military portions. But if one looks at it from a narrower standpoint one sees how this educational problem is daily getting more important, since it is fast becoming impossible for regimental officers to take charge of all warlike stores and material, because the scheme of their scientific education falls short of what is required for this purpose, and the result has been that specialists have had to be introduced and are likely to go on increasing in number.

With regard to technical education we are not so far removed from civil life as to make it impossible to draw comparisons between what has been done in this matter during the last few years among the engineering and kindred classes, and the present tendency in the service.

If one glancés back at the history of "technical instruction" in civil life one finds that at first attempts to give education to the workers was looked upon in much the same way as technical courses are looked upon by many officers, and that one of the chief reasons why it was regarded with general distrust was that this so-called "technical education" was never of a practical nature and men's minds were imbued with theoretical ideas which were of no use to them in the carrying out of their everyday work. This feeling that there is no immediately realizable value for what is taught in a technical school, pervades nearly all the letters in scientific journals raising objections to the present system.

The same general idea is common enough in the service. We all know that most men look upon what they learn for their various examinations as of no practical use to them in future life. The object of combining scientific with practical work is discussed by Major E. S. May, R, H. A., in the commencement of his lecture on the "Study of Military History as a Means of Training for War," published in the *Proceedings of the Artillery Institution* for August, 1897, and although this article is on a purely military subject, yet the principle is true in all branches of life. Certainly it holds good in the garrison artillery; no one could say that because an officer has educated himself in all the technical sciences which belong to his branch of the service, that therefore he will most likely be an indifferent regimental officer, only taking an interest in the scientific developments of the day. On the contrary, by reason of his education his opinion should be of great value in all questions relating to the efficiency of scientific instruments or material generally.

The idea of technical education for artillery officers is no new one, for there exists a pamphlet written in 1875 by a general officer, entitled, "A Plea for the Better Technical Education of Artillery Officers." The general idea which this officer had in mind seems to have been somewhat as follows: that officers should have such a sound knowledge of scientific principles and have their minds so trained in technical details as to be able not only to keep up with the times in all questions affecting material, but also to express such opinions as would be a guide to manufacturers in calling their attention to the real requirements of the service, and to strongly press their views upon the government, so that there should be no excuse for any falling behind hand in respect of design, etc., in the material supplied for use with the Royal Artillery.

If any extra training was required in former years to enable officers to express such opinions, much more so will it be the case now when every day science is advancing and mechanical principles of all kinds are being introduced into designs for warlike stores, so much so that perpetual changes in the armaments must continue if we are to keep only on a level with our neighbors on the Continent. Just as Professor Tylden's words, spoken many years ago, must be recognized as having much truth in them, namely, that England would lose her industrial supremacy by virtue of the better education provided by Continental nations, so also his words, "that we would be outstripped by these nations in the arts of war as well as of peace," will come near the truth unless the education of artillery officers as a body is kept up to that standard which is necessary for them to appreciate all the advances of science in modern days. Are we falling behind in the material with which our field artillery is equipped, we have not been the first to take advantage of the quick-firer for field service; in adopting it we will only be copying Continental nations, and it will be some time yet before our field artillery gets the advantage of this advancement in material for field service. Now, if it is necessary that the field artillery be armed with a quick-firer, and as this system is by no means a very modern one, it follows that if officers had been alive to its advantages they would have pressed for its introduction some years ago. Although this essay only deals with the training of garrison artillery officers, yet I mention this as it shows the importance of educating officers so that they may be able to discuss the advantages or otherwise of new or proposed equipment, and here one sees the use of a technical school which would give officers an opportunity of studying the latest scientific devices, point out what is being done at home and abroad in the way of improving the equipment for all branches of the artillery, and would educate officers up to modern ideas. Mechanical combinations which formerly were looked upon as of a complicated nature are now thought simple in the extreme and applied to numerous service purposes. The advantages to be gained from modern inventions should not be thrown away because at first sight they appear and are stigmatized as "complicated." Breech-loading guns must have appeared very complicated, compared to rifle muzzle loading when first introduced, but these latter had to give way in front of the advantages of the later invention. The familiarity of modern mechanism which would be gained as a result of technical education would cause a revulsion of ideas as to what may justly be considered "complicated."

Are officers of the garrison artillery satisfied now with the armament supplied to their branch of the service? If not, they must be prepared to show in what direction the improvement lies, and also that the scientific reasons on which their arguments are based are worthy of consideration. I do not see how one can ever rest satisfied, because any arrangement which, as a whole, is made up of mechanical, electrical and other devices must be capable of improvement as time goes on; only if one has not got the technical knowledge to combine with one's everyday work, how can one point out that the application of some new scientific discovery would be of increased advantage to the system with which one has to deal, or suggest any slight improvement if one knows not the principle upon which the mechanism is based, or even compare our own armaments with those of Continental nations?

The opinions of all regimental officers, not alone of those specially trained and in special employment, should be extremely valuable in all questions of change in material, provided always that their technical knowledge is of a sufficiently high standard; much good can result from criticism, from argument, and from a greater interest being taken in material. Of late years much attention has been paid to drill and fire discipline; regular systems have been worked out and, due to the School of Gunnery, have permeated through the service. Not only those who go through the long course, but every officer, is prepared to criticize the principles on which the drill and fire discipline rest, and has his own ideas as to alterations and improvements. We frequently see letters and essays on the subject of the drill and training of the garrison artillery, which shows that these subjects are thought about and discussed. What we want is a similar school for leading officers to think on technical subjects, keeping them posted up in all the latest developments and getting officers to understand that on themselves chiefly depends whether their armament is as efficient as it should be or not. If officers had only a higher scientific knowledge, the suggestions they would offer would soon be acted upon in the manufacturing departments and we should have many simplifications and much improvement in our scientific instruments. The regimental officer whose daily work is connected with coast defense is best qualified to say where alterations or additions are necessary, if only he be sufficiently progressive. This is an age in which things scientific cannot stand fast for a moment, but still I consider that, educated to the right standard, he is in the position to make the best use of his knowledge, and, being acquainted with the practical application of the question, he is the less likely to fall into that error of making a machine which, though theoretically perfect, yet does not satisfy the practical requirements of the artilleryman.

The course which is considered necessary for a Gunnery Lieutenant of the Royal Navy might now be compared with some of those which are open to Royal Artillery officers. The duties of a Gunnery Lieutenant approach somewhat to those of a Gunnery Instructor in the Royal Artillery, as far as one can liken work afloat to work on shore, and one would therefore expect both courses to be to some extent similar, but one finds that the naval course is, from a scientific point of view, far in advance of the corresponding course with us; it is, in fact, a combination of our "long course" and "senior class."* In the naval course, in addition to the work in connection with drill and training, some considerable time is spent over the study of material, and officers are expected to be thoroughly up-to-date in scientific developments as applied to armaments and to have some idea as to how we stand in this matter in comparison with other countries. At the same time the theoretical study af such subjects as mechanics, electricity, chemistry, etc., is not neglected, eight months being devoted to this portion of the course, sufficient to give officers a grounding in the elements of these sciences, and to be a help to them in appreciating and understanding the numerous complicated pieces of machinery which form part of any armament. This grounding can then be developed if necessary, in after years. The period under instruction in the navy is about two years, while in our long course it is for one, out of which only three months are devoted to technical subjects and the study of material. The differences mentioned above in the education of those whose duty it is to instruct others in all the latest developments, whether of drill or of warlike stores, must cause a contrast between the two services which regard to the importance in which "matériel" and the sciences is held.

That some importance is attached to this subject of technical instruction is apparent in looking through the list of books printed at Government expense and circulated for the benefit of officers, etc.

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* Also known as the "Advanced Class."

There are no less than seventeen treatises and manuals on various technical subjects, and many of them large works containing a vast amount of information in material generally and in scientific subjects. But with the exception of those who are going or have been through courses the contents of these books is matter of little interest to officers of the garrison artillery, for the reason that they have not been forced to keep up the groundwork of that technical knowledge which they learned at the Royal Military Academy, and without it the books are uninteresting and heavy reading.

Granted that technical education is necessary for the officers of a scientific branch of the service like the garrison artillery, then for purposes of instruction officers can be divided up into two main classes—those who elect to take appointments in the manufacturing departments, inspection staff of the Army Ordnance Department or in similar branches of the service, and those who prefer to remain for most of their service as purely regimental officers. With regard to the first class, little need be said ; they are all men who have passed through the senior or firemaster's* course, or else have shown that they possess qualifications for this kind of work. They are, in fact, men with considerable technical training. The education provided by these courses is necessarily limited by the time allowed ; only main principles can as a rule be attempted, and an officer after taking a foundation on which to work and without which he would be incapable of expressing opinions likely to be respected by scientific men. With regard to the regimental officer I have already endeavored to point out that from the standpoint of " pure education " it must be an advantage in all classes of life to have to deal with scientifically trained men and an especial advantage to the State in the case of its garrison artillery officers, whose duty it is to take the lead and point the road which improvements in warlike stores must follow. In addition to this, other reasons of a more regimental nature can be given why artillery officers should be technically trained. What are the objections raised to courses of instruction for regimental officers?

It may be as well to state some of them at once.

Firstly—It is said that the first duty of a regimental officer is to his men ; to attend to their drill, training and instruction of the company, study discipline, interior economy and so on, and if he carries out these duties properly, it is as much as can be expected of him.

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* Now called Ordnance Course.

Secondly—If they are given a course of instruction in electricity, steam, hydraulics, care and preservation of mountings, etc., they would soon forget all about it, because they would never make any practical use of their knowledge, there being specialists of all kinds told off to do this work.

Thirdly—For fear of doing damage, or for fear of causing friction with some other department, no officer will interfere with any portion of the armament or endeavor to repair a damage if he can possibly avoid it. I propose now to dispose of these objections *seriatim*, showing at the same time what advantage would accrue from the training of regimental officers.

The first objection is a question as to whether an officer can combine the scientific knowledge which he is to acquire with the regimental duty which he is already doing and do it better than before. Very possibly all cannot, but there will be some, very likely the majority, who will so benefit by a course of instruction that a new world of thought will be opened before them, and they will be disposed to investigate the reason of everything which they see working around them.

As has been advanced in favor of technical education in civil life, "it teaches men to understand some of those phenomena and laws of nature which ordinarily lie hidden just beneath the surface of things most common to them." This will not detract from a man's capacity for military duties in any way, but enable him to combine with them such knowledge as would lead him to offer suggestions for the simplification of the systems of drill and fire discipline. In future wars in which garrison artillery may be called upon to take part superiority of weapons seems even more likely than ever to produce momentous results, and by weapons in this case is meant not only the gun itself, but also the mounting, ammunition and the numerous scientific devices which are employed to make each gun part of a combined system, very powerful so long as each link in the chain is doing its proper work, but much less so when through any failure in material or design a break-down occurs. Should not every garrison artillery officer be well acquainted with the principles upon which the smooth working in each link of the chain depends—whether it is an electrical appliance as in a telephone or firing circuit, or a mechanical combination as in a breech mechanism, or some principle of hydraulics as in a buffer of a mounting, etc.

The second and third objections are closely connected ; they open up the whole question of the "advisability or otherwise of employing specialists."

To my mind the mere employment of specialists points to the fact that we recognize the inability of the ordinary company officer to do the necessary work connected with garrison artillery armaments. These specialists belong to two branches of the service—firstly, to the army ordnance corps, amongst whom are the inspectors of ordnance machinery and the armament articers, a most important body of men, for on them devolves the duty of keeping the armaments in a state of efficiency; secondly, to the regimental establishment of the garrison artillery, which includes among the officers gunnery instructors, inspectors of range finding, etc., and, among the men, gunners, as range-finders, machinists, etc. Those who are highly skilled mechanics like the Inspector of Ordnance Machinery and his assistants, the armament artificers, are necessarily limited in number, and even in time of peace they are fully occupied in carrying out the necessary inspections and examinations in their districts. What would happen in time of war? Their work in time of peace is necessary for the keeping up of the armament in a proper state of efficiency; it is not mere ornamental work which could be dispensed with. One can easily conceive a case when they would be quite unable to keep pace with the work. Supposing that only part of the district had been engaged, numerous small repairs would be necessary, for we have some idea of the damage to material that would be caused by a hail of quick-fire shells; also after firing a number of rounds many mountings, etc., may require careful examination and parts replacing or adjusting. Meanwhile the rest of the district must be kept in a most efficient state, even more so than in peace time. At home, drill would probably be carried on daily by militia and volunteers, all of which would give increased work and necessitate much supervision of the armament, or supposing some new work had to be undertaken while a state of war existed, a new mounting put up, for example, this would require the personal superintendence of the Inspectors of Ordnance Machinery for a week at least and would employ several of the armament artificers. Meanwhile the ordinory work must fall behindhand; it would be impossible for the Inspector of Ordnance Machinery to see to everything himself. Great responsibility must be thrown on the armament artificers. Would the result be satisfactory? Should these non-commissioned officers be placed in such a position? Would it not be much better for the regimental officers, or at any rate a certain proportion of them to be so trained as to be capable in case of necessity of doing work similar to that of the Inspectors of Ordnance Machinery? These officers could then at any moment be called upon to examine the armament, and with the assistance of the artificers rectify any defect. Should a casualty occur amongst these specialists, which would be only natural, then a trained officer might, by making use of the machinery gunners, be of great value in surmounting some difficulty of the moment when these men's undirected efforts would probably be of little avail. Again, take the case of a boiler and engine employed in connection with the armament; are they to be dependent on a few specialists? Why should not all regimental officers understand the principles of stoking, the working of the engines, and even have some idea of repairs. There must be many officers in the Garrison Artillery who are capable of profiting by a thoroughly good training both in theoretical and practical branches of mechanics, etc., but when trained, the second objection which I have mentioned must be overcome by encouraging them in every way to keep up their knowledge by being present when the I. O. M. is inspecting or carrying out repairs, etc., and whenever the slightest breakdown occurs or a defect is developed they might be called upon to state what they consider the proper remedy, in this way they would be able to apply their theoretical knowledge and gain practical experience. These officers must be company officers, what is wanted are men who can combine their regimental knowledge with a fair share of scientific or mechanical training, men to fall back on in case of need. Some people advocate the abolition of the specialist altogether, urging that those who work the armament should also look after it and be responsible for its care and preservation; although there may be much advantage in this, it can hardly be possible with so much machinery, etc., as in use at the present day, occassionally high mechanical skill will be required and an officer cannot be expected to attain to this in a short time. There must be someone to fall back on or refer to in case of need, and we must have a corps of mechanics to carry out this work, but to rely in time of war on one or two specialists keeping the whole of the armament in an efficient state seems to be running an unnecessary risk. To overcome objection three, the regimental officer should at practice be supreme, if any gear breaks down of whatsoever nature, he should remedy the defect to the best of his ability; in case of need he can call to his assistance the armament artificer who might be present as he is now, and who would gain as much experience in seeing the attempted remedies of others as if he did the work himself. Under existing conditions the regimental officer considers that he will be held responsible for any damage he does if he attempts to interfere with the armament; he may say that in time of war he would not hesitate to adjust gear, repair electrical appliances, but could he do it; he has little scientific training to help him, and has gained no experience in times of peace; if he does damage in gaining experience, the State should pay for it, as the State gets the benefit of his experience, but there is no danger of such a thing occurring with any officer who brings to bear in each case the principles which he would be taught at any technical school. On the peace establishments of the Garrison Artillery the following specialists as regards armament work are shown:—Armament Majors, Armament Captains, Captains for district duties, Lieutenants for district duties, Gunnery Instructors, and Inspectors of Range Finding. At Malta these total up to 15 and at Gibraltar to 24, although at present there are not officers selected for all the appointments. By giving an increased training to company officers, all these specialists could be abolished—in this way company officers, who in the course of time would all be men with a fair amount of training, would be able to take entire charge of the armament with which they work. If we argue that very specially trained officers are necessary to look after Range and Position Finders, Telephonic Communications, etc., in time of peace, then we are in the same position in time of war as with other specialists, owing to extra work and numbers reduced by casualties they will not be able to carry out their duties effectively and in most cases there will be nobody to fall back on, for the ordinary regimental officer will not have considered it necessary to keep up his electrical knowledge and other scientific acquirements. There seems to be no objection to some slight amount of specialising in the compamy itself so long as officers are not allowed to fall into grooves; one subaltern may be more fitted to look after delicate instruments or electrical applicances than another, then let one take charge of such instruments, if there are any in the district, and let another interest himself chiefly in mountings, etc., and so on, and with regard to a gunnery instructor it should be possible to have in each company one officer who has been specially trained, by going through the Long Course or some similar course of instruction. In this way with a little extra training, many of the disadvantages of having a number of regimental specialists acting independently in a district would be done away with and all the work in the sub-district would be concentrated under the officer commanding the company who would be in charge of it in time of peace and fight it in time of war.

How are the regimental officers to be instructed in technical subjects so that they may take the place of these regimental specialists and be capable if necessary of supplementing the work done by the I. O. M.? Several ways present themselves :—

(1.) The course of instruction at the Royal Military Academy might be extended and the last six months devoted entirely to technical subjects such as are considered necessary for a Garrison Artillery Officer.

(2.) The instruction might be given in districts.

(3.) A new branch of the School of Gunnery might be started, which would deal entirely with material.

(4.) Lastly, this work might be undertaken by a special Institution like the Ordnance College.

The first point to deal with is whether the instruction shall be given before the officer joins a service battery or after he has attained a few years service. I have no hestitation in saying that the latter is the proper course to pursue, turning again to the conditions of civil life the general opinion as far as I can gather with regard to young men entering various branches of engineering and kindred trades is—"that if all the school work is done first, then when the young man enters his shop work, he thinks he knows everything and offends workmen who have been working at the subject for years and who could teach him much." He ought to do elementary school work first, then a shop course, then go back to complete his school training for when he goes back to school, he can appreciate why he is learning what is put to him. Applying the general principle of this idea to ourselves, the elementary school training is that given at the Royal Military Academy, the shop work is the training in a service company, and the second school course is proposed to be given at some special Institution. The argument seems sound, let the young officer get a good general course of military education coupled with necessary elements of science, as a cadet, and then join a service company in order that he may learn what work in the Garrison Artillery means, what conditions he should fulfil as a Garrison Artillery officer, and then give him an opportunity of completing his technical education which he will now be able to do with profit both to himself and to the country. With regard to the first method proposed, I see no advantages beyond economy and that of a false kind : I have already stated why a "post graduate" course should be instituted, moreover, I think that it is safe to assert that cadets at the Royal Military Academy do not realise the importance of the work they are doing, their eyes are turned to the purely military side of their profession and in the first few years of their service they seldom give a thought to the principles and theories ot the technical subjects which they have been taught—then when the novelty wears off and the peace soldiering becomes a little tame and monotonous, interest in the technical portion of their profession should be awakened ; in a few cases this is a voluntary action on the part of the individual, such men join the Senior and other classes, but in most cases the start must be made compulsory. There are many men who are unaware of the capabilities which lie within them until they join some course of instruction, men who showed no mathematical ability at the academy have been known to develop mathematical talents of no mean order when obliged to take up the subject as part of a course, and what applies to mathematics applies equally well to other subjects.

If the second method was adopted an officer in each district must be selected as an Instructor ; supposing that the Instructor in Gunnery is retained as a specialist for this purpose, then the instruction which he at present receives in the "Long Course" would have to be supplemented very considerably as he would be expected to be an authority on many technical subjects, in fact he would have to pass through the senior class as well as the long course—then again there would be the danger of his considering the technical instruction as secondary to the gunnery or *vice versa* ; there would be great difficulty in forming a class of officers of any size in a district for any contiuous instruction as they would have at the same to be doing regimental duty with their companies. Lecture rooms with plans, models, chemical and electrical apparatus, etc., would be necessary, which would entail great expense, and then again it would be very difficult to ensure a similar training in each district, however good the superintendance of the whole might be. The armament varies so at different stations that unless guns and mountings were provided for instructional purposes, some officers, as far as modern appliances are concerned would benefit little by the course. At a few stations only could instruction be provided in the care of engines, boilers, practice in stoking, etc. The cost of carrying out this system is likely to be considerable, but there is one great advantage namely, " that officers would not be taken away from their stations and so in many ways lose touch with their companies."

Method 3.—There may be some advantage of combining different branches of educational work under one head, but there are many disadvantages, one branch is sure to be put forward at the expense of another and centralization can be carried to too great an extent. The School of Gunnery is already a large institution and is now established in various parts of the country, if it takes up such a subject as technical training, it must if it wants to be thorough, keep the subject distinct from ordinary drill, this means a separate staff and would be in fact a combination of the Ordnance College and the School of Gunnery ; if only the regimental officer had to be considered this might be the proper thing to do, but as long as officers have to be trained for special work such as the Inspection Staff, Army Ordnance and manfacturing departments, a separate institution with every modern appliance is necessary. It might be claimed for teaching technical subjects at such stations as Shoeburyness, Golden Hill or Plymouth, that the practical application can be shown in a battery, and that the imagination has to supply nothing, in combining the theoretical portion of the subject with its practical application; this may seem a good deal to some but to anyone who has taken an ordinary interest in the armament in his station, the application of general principles should not be a source of difficulty. These latter remarks appear to be the only practical gain of this system and against this must be put the expense of two separate technical schools, one the Ordnance College for the higher training of men selected for appointments, and another for the instruction of regimental officers generally.

Method 4. Seeing that there is a necessity for a separate institution at Woolwich to teach technical subjects, the simplest solution of the question is to form courses for regimental officers at this School of Instruction. The Ordnance College is already provided with well equipped chemical and electrical laboratories, has the advantage of being able to make use of all the material in the Arsenal, not only in connection with guns, carriages and ammunition, but with engines, boilers, machinery, electric light, etc. ; technical instruction is its main object and that in the fullest sense of the term. By giving the training to all officers at the same place, a systematic course, including all the latest ideas, could be provided for, and a fixed standard worked up to.

Supposing that every officer of the Garrison Artillery is put through a course of technical subjects after not less than two years service how many will have to be struck off duty annually for this purpose. It appears that about thirty-five to forty officers are added to the Garrison Artillery yearly. From this total must be deducted those officers who go through such courses as the "Senior" or "Ordnance" without going through the regimental course, probably all that would be left would be thirty to thirty-five; a very small number. The length of the course should be six months, longer if possible. When one comes to consider what the teaching of technical subjects means, how closely connected they are the one to another, how, for example in the teaching of electricity, some knowledge of chemistry, heat, etc., is necessary, and so on with other subjects, and then that the application of all these subjects, chemistry, electricity, heat, steam, mechanism, etc., has to be considered with reference to the various service purposes, such as range finding instruments, communications, mountings, ammunition, firing gears, etc., etc., one sees the uselessness of a course of less duration than six months. At the end of the course an officer should be allowed to spend a short time, from a fortnight to a month in studying that subject with which he is especially connected in his own company. For example an officer whose charge included range finding instruments might work for a few weeks with the Inspector of Range Finding, Woolwich, and so on. The proposition is that every officer in the Garrison Artillery, some time after two years service, shall go through a six months course at a service technical college. At first sight it would appear as if this would necessitate the withdrawal of many service officers from their companies for a long period of time, but I do not think this is so; for first of all there are only some thirty officers to be put through annually, that is, with two courses, fifteen in each; these fifteen would have to be drawn from home companies or those near home, such as the Channel Islands, Malta or Gibraltar. With reference to this question of the withdrawal of officers the following points must be considered:—

(a). The period of the Long Course at Woolwich could be shortened by two months, if the officers had previously been through a regimental course.

(b). The special class could be abolished, which at present absorbs from eight to twelve officers annually.

(c). The position finding class would be amalgamated with the regimental course, which saves another six to twelve men.

(d). If there were no regimental specialists there would be more company officers to draw upon.

Six months out of the period during which an officer is a Lieutenant or Captain say some eighteen years, is all that is required for the technical course, and another six months would provide for a good gunnery course for Garrison Artillery officers. On looking at the Regimental list, it appears that a great many officers go through a course of some kind, some have gone through two or three ; the training proposed would therefore not amount to any great increase in the time to be spent on courses.

What is sought for is a scheme which would ensure a systematic course of technical training ; at present one officer is instructed in electricity, another in steam and hydraulics, and so on, the result being that each officer works as it were only in a small circle and cannot take that broad view of the sciences which is necessary, if his knowledge is to be of any use.

All officers would be equally well trained and capable of understanding the principles upon which scientific instruments are based, and not only would they feel, that with regard to the material in their charge, they were no longer in the hands of a few specialists, but they would take an interest in discovering defects and imperfections and suggesting improvements which would eventually lead to vastly improved systems of defence. Again I do not think that there would be any scarcity of officers for the higher education as given in the Senior Class if all had been made to keep up their knowledge to a moderate standard—it is when officers have forgotten everything which they were taught as Cadets that they hesitate to plunge into the whole subject again.

Are other countries alive to the advantages of education generally ? I do not think there is any doubt about this, taking Germany as an example, all her great commercial advancement during the past few years is generally ascribed to her systematic technical teaching—undoubtedly the same spirit must be felt and recognized in the army and it would be well to see whether we in the service are keeping pace with these modern principles or whether we are inclined to lag behind as has clearly been the case with that portion of our civilian element, which goes to make up the great body of men in trade and commerce and who are now suffering by loss of influence in the commercial world from their neglect of that education which we are too fond of looking upon as only fit for school boys and theorists.

It is not so easy to compare the system of education of one country with that of another, as it would seem at first sight. Unless one is in the country or has spent some time there and conversed with those who have studied the subject, one is dependent on short written descriptions and various syllabuses of instruction. Now a syllabus should be a very good guide but I do not think it is, because it can be so easily worded as to lead one to believe that the course of instruction to which it refers fulfills conditions, or supplies a demand for knowledge which in reality it does not, it gives one little idea of the standard to which a class is expected to attain.

To one point I would especially draw attention. In foreign technical schools it is customary for the students to investigate subjects which can be of use to the manufacturers of the country. for example, supposing that there was any difficulty in obtaining a fast dye of any particular color, then those students who were well versed in chemistry would be told off to find a remedy and in this way part of the money paid to keep up the schools returns in the form of commercial successes. The same principle could be applied in the case of a service technical school in this country, there are always many subjects requiring investigation which by being referred to advanced students is such classes as the "Senior" would serve to give renewed interest in their work and be a saving in expenses to the country.

I have already mentioned Germany as alive to the necessity of education, let us see as far as possible what she is doing to instruct her officers, especially those of the Foot Artillery. In Germany, candidates for commissions first pass an educational test, this would correspond to our entrance examination for Woolwich or Sandhurst. After six months service with a regiment, nearly all officers must pass through a War School, the only exception are those who have been highly educated either at a University, high class *technical* school, or in the "Selecta' class of cadets, this course would correspond to our course at Woolwich or Sandhurst; but in addition to the above, Artillery officers, after at least one year and nine month's service have to pass a special course which is of a decidedly technical nature and lasts for nine and a half month's, after which four weeks are spent at a school of gunnery; those who pass highest in the course can then be selected, to continue their technical education and become fitted for special appointments. It is this technical instruction which is wanting in our service. It may be said that it is combined with the military course at the Academy, but the great disadvantage of such a system is, that the officer (cadet in this case) can bring no professional knowledge to bear on his instruction during the course, while in the German service at least one year and nine months is given in which to gain a general idea of the requirements of the Artillery service before commencing the technical course; and further the German system recognizes the fact that selection is necessary for those men who are to be highly trained, the majority can only be taught up to a certain point, beyond that a few must be chosen, and the method adopted seems a good one because those officers wishing to be selected will work hard during the first part of the course and will therefore be in a fit condition to receive further and higher instruction. So far only the regimental officer has been mentioned, when we come to certain special classes such as correspond to our Ordnance or Senior Class, we find the course far more thorough than anything we can show, three years is the length of time allowed and every advantange appears to be given to the students to acquire knowledge; they should therefore be educated up to a standard far surpassing anything in this country. Another country which is fully alive to the advantages of education is the United States of America. With regard to the training of its officers, the system followed in that country is as follows:—

Cadets are admitted to the United States Academy on passing a qualifying examination, which is of an elementary character but when once admitted they are subjected to a course extending over four years and of a very severe nature; among the technical subjects taught are, mechanics, astronomy, sound, light, chemistry, heat, electricity, magnetism, mineralogy, geology, ordnance, explosives, etc., and judging by the marks obtained the work must be of a very high order. After the four years of study, cadets are appointed to the various arms or corps, those passing highest on the list are recommended for commissions in the Engineers, Ordnance and Artillery; Cavalry and Infantry coming in last. In addition to the Academy which is at West Point, there is an Artillery School at Fort Monroe. It is intended that every artillery officer shall attend this school at least once before promotion to the rank of Captain. The subjects which are taught are: 1, Artillery, 2, Ballistics, 3, Engineering, 4, Steam and Mechanism, 5, Electricity and Mines, 6, Chemistry and Explosives, 7, Military Science, 8, Practical Military Exercises ; also photography, telegraphy and cordage, all these are technical subjects except numbers 3, 7, and 8 ; 3, includes fortifications, 7, strategy and tactics, and 8 is drill, practice, fire discipline, such subjects in fact as in our long course officers are taught at Shoeburyness. Looking at the syllabus of instruction there can be no doubt but that all these subjects are gone into very thoroughly. Here then is a course for regimental officers which comprises military and technical subjects, it is similar to that which could be obtained by adding on to the School of Gunnery a technical department, and this is the arrangement which I stated would be best, if regimental officers only had to be considered. The length of the course is two years which seems unnecessarily long even when military subjects are included and such a length no doubt is not practicable in this country ; but the fact remains that the Americans recognize the value of educating their Artillery officers to a very high standard. Officers have to pass in all the subjects mentioned above, during the two years in which they are under instruction, but those who take honors at the examinations are permitted to spend two more years at the school on condition that they specialize in one or more subjects. Here again is the principle of educating the mass up to a certain point but then selecting the few for the higher education. It is clear then that both the United States of America and Germany considers a good technical education of some value to their Artillery officers, and there can be no doubt but that the people of both countries are "practical" in spite of the interest they take in *theoretical* instruction. With regard to other countries, France, Russia, Italy, for example, as far as I can ascertain, a system somewhat similar to our own is employed with this difference that the instruction given to cadets or officers at the commencement of their service, is extended over a longer period than with us. For example in France and Italy two years are spent at the "Ecole Polytechnique" and then immediately following after that two years at the "Ecole d'application" this of course is a more thorough training than we give to our Artillery officers. In France at any rate, if not also in Italy, there are at various headquarters model rooms, laboratories, and so on, where it is intended that officers shall work and keep up the technical knowledge acquired at the "school of application." In Russia there is an institution very similar to our Ordnance College, but as with us, it is intended for special classes, although a large number of officers appear to be put through. It seems therefore that with regard to this subject of Technical Instruction, we are certainly not in advance of most other countries, and that we are behindhand in comparison with those who give a post graduate course to their officers and with countries like France and Italy, who in addition to a two years course correspoding to that which our cadets undergo, send their young officers for two years more to the "Ecole d'application." What class of instruction should be provided for a regimental course? There will be the same difficulty in settling this question as there is with regard to the same point in civil life. In the many articles which are written on the subject of Technical education, in science journals, one repeatedly comes across the suggestion that the class of instruction afforded is not what is required and consequently no useful results follow and it is laid to the charge of this faulty system that technical education does not "pay" from a commercial point of view and does not yield results commensurate with its expense. Although there are many who find fault with the existing conditions, yet there appear to be very few who are prepared with any scheme for their improvement. This is frequently the case: it is easy to find fault, but not so easy to find a remedy. These letters of criticism however, serve one good purpose, they enable one to foresee the dangers which one must steer clear of, in instituting any similar system of technical education in the future, and as they are general in their application I mention them here :—

1. Too much must not be attempted, it is useless to soar too high and produce a commodity for which there is a scanty demand. Many men with an intimate knowledge of the Integral Calculus and theories on all things visible and invisible are not required, what are wanted are men well grounded in all the important elements of science and technology.

2. The instructor in a technical school is not the man most fitted as a rule to teach "Workshop methods" if these are necessary they should be learnt in the workshop; his work is to teach "root principles" which should underlie all methods now and always.

3. Results must not be judged from "examinations" for if they are, then the instructor's time and energy are wasted in cramming students for the purpose of obtaining marks, in order that the appearance of a high standard of efficiency may be kept up.

4. There must be no stint of practical and theoretical appliances in the school.

5. It must be remembered that educatiion is only the accumulation of stores, the bricks and mortar in fact; on the initiative skill of the students, on his constructive power depends whether he can make any use of the materials collected. In any scheme for introducing technical education into the service, the teaching of the sciences with a view to their application to military purposes only, must be guarded against. Time must be spent in acquiring a good fundamental knowledge of each subject, this is a drudgery which cannot be avoided, the application follows as a matter of course.

It would be useless to give here a detailed syllabus for a six months course of instruction for regimental officers ; many of the subjects mentioned at the commencement of this essay would have to be touched on, over some much time would have to be spent, while others could be dismissed in a few lectures. It would be very important to distinguish between those subjects which are likely in the future to play an ever increasing part in connection with the appliances used in coast defence, and those whose *rôle* is decreasing day by day—among the former would be electricity, the application of which to service stores would have to be dealt with thoroughly, if all regimental officers are in future years to be capable of carrying out the duties now performed by trained specialists. The inspection, care and preservation of all warlike stories, whether they come under the heading of guns, carriages, ammunition or instruments, should be understood by all officers, so much of the various sciences should be taught as would enable officers to do this, and also to draw right conclusions from accidents or any other peculiar circumstances which come under their notice, and so frame reports which can be of service to others.

No more need be said with regard to the details of the syllabus. The instruction must be sufficiently general to avoid the reproach of being formed for one particular purpose, or to bring to the front one particular subject, and it must be sufficiently practical to be of use to officers in their daily work ; general principles must also be taught as well as practical methods.

THE DEVELOPMENT OF SMOKELESS POWDER.*

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PART I.

The systematic development of improved ballistic properties from progressive explosives constitutes one of the most important ordnance problems of the present day. The idea is beginning to gain ground among us that hereafter we must look to the powder, as well as to the gun, in our efforts to increase the rapidity of flight and the penetrative power of projectiles; that we must consider the source of energy at our disposal conjointly with the apparatus whose function it is to convert that energy into useful work.

As long as the art of powder making remained at a standstill—as it practically did for several centuries—while the practices of alchemy, rather than the principles of chemistry, may be said to have controlled the manufacture of all explosives, the best that could be done was to follow the progress of mechanics in efforts to effect ordnance improvement; guns were built and powders were found to fire from them. To day, however, not only is the composition of powder undergoing modifications, but new explosive compounds, whose development is based upon chemical discovery, are coming into general use; the results of investigations into the chemical and physical properties of explosives, systematized and co-ordinated by the methods of mathematical analysis, have so increased our knowledge of ballistics that designers of ordnance are forced to accept new conditions as factors of prime importance in the attainment of ballistic effect.

For purposes of comparsion, the old forms of powder, such as black gunpowder, may be regarded as imperfect mechanical mixtures of particles of the materials of which the powder is composed; the new explosives, as very intimate mixtures of the atoms of those elements from whose union into molecules the substance of the explosive is formed. When the old powder is employed as a fine dust it burns with great speed and violence;

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when agglomerated into grains† it burns in a slow, progressive manner. If the grains of the old powders become disintergrated before they are completely consumed, through effects of heat and gas pressure developed in the bore of the gun, the grains crumble away, pressures become violent, and regular progressive combustion ceases to obtain. Similar but not identical conditions exist for the new explosives. In the form of dust they burn with exceeding rapidity and great violence ; when all the particles are decomposed simultaneously they detonate ; by building them up into dense grains they *may* be made, under favorable conditions, to burn progressively.

It was obvious from the start that many advantages were to be obtained by the substitution of the new explosives for the old as progressive powders. The former burned up completely, leaving no residue. Many of them made no smoke. Other conditions being equal, these two qualities alone would have been sufficient to justify their general adoption. But other conditions were not equal. Up to a few years ago the fact remained that no positive, certain way of making nitro-explosives burn progressively had been found. All known precautions could be observed in the preparation ; they could be built up into dense grains with the greatest possible care ; yet, every now and then a charge of the powder would detonate—that is, instead of burning progressively, in accordance with the finished form of its grains, it would burn as the dust from which the grains were built up. A gun would be shattered, perhaps a life or two lost, and then all confidence in the new material would disappear, the chosen line of development would be abandoned; no fundamental facts would be left unchallenged to anchor new hopes upon.

Until some way could be found, then, of firing a nitro-compound from a gun with positive assurance that detonation would not occur, there could be no change from the old powders to the new. This assurance was obtained by the discovery that nitro-cellulose, colloided and formed into grains of regular size, would in all cases, if ignited in a closed space, burn away in a progressive manner, at a rate proportional to the form and dimensions of the grains and to the conditions of their confinement. Two proofs made the fact that colloids would not detonate certain—first, that the grains of colloid powders that were shot out of the gun without being completely consumed preserved the original shapes, in reduced dimensions, of the grains of which the powder charge was primarily composed ; second, that not tens, nor hundreds, but thousands of rounds of colloid powders, fired in guns or exploded in closed vessels, developed in every case pressures that could be shown to correspond rationally, in accordance with the theory of progressive combustion, to size and form of grains and to dimensions of gun chamber or explosion bomb. To make these facts certain, pressures were carried up beyond the 33,000-pound limit allowed for cannon, and in explosion bombs to well beyond 100,000 pounds per square inch.

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† By "grains" is to be understood any regular form--flat strips, rods, cubes, etc.

Now, as the only certain way yet found of avoiding detonation and of assuring progressive combustion is through the colloiding of nitrocellulose, and as nitrocellulose alone can be colloided, it follows that we are definitely limited in our choice of material for progressive powders to a certain preparation of nitrocellulose. It is true that a number of substances, such as nitroglycerin and nitrates of metallic base, may be distributed in minute particles throughout the body of the colloid, and that immunity from simultaneous detonation may be secured for the particles so distributed, but they all remain uncombined in the colloid—the nitrates as the sand or minute shells in the body of a sponge, the nitroglycerin as the water in the pores of the sponge. It is desired to emphasize by this comparison the fact that all the new powders, without exception, must be built up from some form of colloid nitrocellulose, whether they contain other ingredients or not. Thus, in the case of those powders containing nitroglycerin we may reduce the percentage of nitroglycerin to zero—that is, we may eliminate it. If we were to remove the colloid nitrocellulose from such a powder, we would have remaining nitroglycerin, which would detonate in the gun upon the attempt to fire.

Nitrocellulose, which is usually prepared by dipping cotton into nitric acid, possesses a property which the cotton, before dipping into acid, does not—*i. e.*, of dissolving in a number of substances. One of these is acetone, a volatile fluid, with a characteristic pungent and aromatic odor, somewhat suggesting common alcohol in appearance and properties. Another solvent for another kind of nitrocellulose is a mixture of ether and alcohol. If the clear liquids which constitute the solutions in these substances be evaporated, there will be obtained, not the nitrated cotton in its original fibrous form, but first a sirupy liquid, then a jelly, and finally, as dryness is approached, a solid translucent mass, varying in color according to the variety of nitrocellulose from which it is prepared, from a straw yellow to a chocolate brown, and generally suggesting, in its various forms, tortoise shell. To such a substance the appellation *colloid*, from its glue-like consistency, has been applied.

The general name for the material produced by steeping cellulose into nitric acid is nitrocellulose. One of its common forms is gun cotton. Chemists are well aware that there are many different kinds of nitrocellulose, but just how many there are no one has as yet even been able to predict, the exact composition of cellulose and of its nitro-derivatives remaining among the yet unsolved mysteries of nature. Three forms were originally assigned to it, the mono, di, and tri, just as there were the three forms of mono, di, and tri nitroglycerin. A later investigator (Eder) succeeded in proving the existence of six. The authority of to-day upon the subject, whose views are now generally accepted (Vieille), has formulated eight. Now, just as there are many varieties of nitrocellulose, so there are many varieties of colloids. The nitrocelluloses themselves all look alike; in their common pulped form they suggest fine white flour. They can be distinguished from one another with ease by the readiness with which some of them go into solution in certain solvents, while others remain undissolved in these solvents like so much sand. The fact that they possess such different properties is accounted for in practice by proven differences in chemical composition. It suffices here to state that there are a number of different varieties of the substance which form a number of different colloids. The question of composition will be considered later in relation to the gases resulting from the combustion of nitro-compounds.

We are familiar with the kind of nitrocellulose used for detonating purposes—gun cotton. We are also famílar with a form of colloid in common use to-day as a material. I refer here to celluloid, now very generally employed for the manufacture of a great number of useful articles. The nitrocellulose from which celluloid is prepared may be made by steeping cotton in weak acids, and is rather a combustible than an explosive; it is a very different substance from the high explosive gun cotton, which is prepared from cotton by the use of strong acids. One solvent used to make celluloid is a mixture of ether and alcohol; the same solvent has no effect upon gun cotton, to dissolve which acetone must be used. We have, then, two different types of colloid to start with—celluloid (formed from weakly nitrated cellulose by the use of ether-alcohol) and the acetone colloid of gun cotton. It may be stated here that these two types of colloids represent all that is important in relation to colloid material for the manufacture of smokeless powder, as the matter has been understood up to a very recent date. The various colloids of the eight varieties of gun cotton above referred to range themselves under one or the other of these two types. We thus have two classes of colloid to experiment with, as gunpowder, and all the information we possess in relation to them is the fact that, however they may burn in the gun, yet they will not detonate.

Suppose that a number of rounds of powder are prepared from the two colloids, how will they act when fired from a gun of a given caliber? Let us assume that we have at our disposal the instruments commonly employed for the measurement of muzzle velocities and of bore pressures, the chronograph and pressure gauges; we will then have, as a basis of comparison, first, the ratios V/P of velocities to pressures*; second, our personal observations of other phenomena attending explosion.

Actual practice shows that the best results obtained for the two powders in a given gun, by varying weights of charge and dimensions of grain, would be about as follows:

Gun cotton-acetone colloid .... $V/P = 2100/15\text{-}19$.
Celluloid nitrocotton† colloided with ether-alcohol .... $V/P = 2100/16$.

Inspection of the results shows the existence of a pressure range of from fifteen to nineteen tons for the acetone powder. This means that while no detonation would occur, yet that pressures would jump between certain limits. Such a phenomenon is often observed in the tests of brown powders for heavy guns. A powder of this character would be unsuitable for general use by reason of pressure irregularity.

Upon firing the celluloid powder another and perhaps worse inconvenience would be met with; considerable smoke would be developed, and the interior of the bore would be found lined, after each round, with a heavy coating of soot, which, after one or two shots had been fired and the gun had become heated, would ignite after each succeeding round upon ingress of fresh air, on opening of the breech, thereby producing flaming at breech and muzzle.

Obviously, as gunpowder, neither the one nor the other form of colloid is suitable. If they are to be employed they must be improved. Irregularity in pressures from the gun cotton acetone colloid is due to brittleness. If we are to use this material, we must devise some means of toughening it. The celluloid does not contain enough oxygen to consume its substance into gases; to use the latter we must put more oxygen into it.

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* A convenient expression for comparing, in a given gun, the ballistic properties of different progressive powders, V representing velocities in foot-seconds, and P pressures in tons per square inch.

† Commonly called "soluble nitrocellulose."

The original phases of the colloid powder question thus present themselves. Neither the one nor the other form of colloid proving suitable for direct manufacture into powder, people began to try to improve them by combining them, or by adding foreign substances to them. It was well understood that no form of gun cotton, however highly nitrated, contained enough oxygen to effect its own complete combustion--the conversion of its carbon into the higher oxide of carbon, CO_2. The first idea of the experimenter was to add enough oxygen to the nitrocelluloses to thus complete its combustion, and this unfortunate attempt led to many years' delay in the development of smokeless powder. It started investigators off upon a wrong track; complete combustion was one thing, and the work necessary to develop highest velocity with lowest bore pressure another.

With the purpose, then, of improving ballistic qualities of powders by causing them to consume completely and to develop regular pressures, experimenters in different countries began to try the effect of introducing into the colloid various foreign substances—generally oxidizing agents, such as nitrates of metallic base—sometimes when the mixtures became too violent in their action, a substance rich in carbon, called a deterrent, was added. Such work was a good deal like groping in the dark. There was no method in it. But there was one great incentive to keeping it up, viz. the fact thereby established that the addition of these nitrates to the colloids actually increased the velocity developed for a given bore pressure, whatever the inconveniences attendant upon the employment of these mixtures as powders may have been*.

To establish a comparison between the ballistic efficiency of the two types of pure colloids above cited and of certain compound colloid powders into whose substance metallic nitrates or other oxygen carriers are incorporated, the following tabular record of performances of powders of these classes is submitted. Note is made therein of objectionable features developed for each of the explosives named.

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* The increase in muzzle velocities for a given bore pressure to be attained by incorporating certain amounts of metallic nitrates, nitroglycerin, etc., into the body of the colloid, constitutes a special phase of development of progressive powders, which will be discussed in a subsequent paper.

TABLE I.

A.	B.	C.	D.	E.
Acetone gun cotton, pure colloid.	Ether-alcohol, soluble nitrocellulose, pure colloid	K. (primitive type, United States). Blend of nitrocelluloses colloided in acetone, with metallic nitrates added.	BN (France, commercial). Blend of nitrocelluloses colloided in ether-alcohol, with metallic nitrates added.	Cordite. (Great Britain). Nitrocellulose, colloided in acetone, with nitroglycerin added.
$V/P = \frac{2100}{15 \text{ to } 19}$	$V/P = \frac{2100}{16}$	$V/P = \frac{2400}{15}$	$V/P = \frac{2400}{15}$	$V/P = \frac{2400}{15}$
Irregular pressures.	Deposits soot	Some smoke and bore deposit.	Some smoke and bore deposit.	Erosion; doubtful keeping quality; some smoke.

Referring to the table, we find powders A and B with properties as already described. The K, BN, and cordite all make good ballistic showings, giving velocities greater by about 300 foot-seconds for a developed pressure than the former.

The last line of the table shows that each of the powders possesses certain unfavorable qualities which militate against its adoption for service use. The gun cotton-acetone colloid develops irregular pressures; the ether-alcohol colloid of soluble nitrocellulose deposits soot; the K and BN produce some smoke and bore deposit. Cordite contains a volatile liquid, nitroglycerin, which develops great heat upon combustion. Now, the development of highest velocity at lowest pressure is most important, even if obtained at the expense of the production of certain partially unfavorable conditions; but there was a further incentive to progress at this stage of development—the fact there had been found a form of pure colloid, unadulterated by admixture with other substances, which, while developing high velocities at moderate pressures, possessed the full round of good qualities necessary in a service powder.

The end sought for in the development of gunpowder is the attainment of the capability of delivering most accurately in a given interval of time the greatest number of most powerful blows, this result to be effected with minimum risk to gunners and with least possible injury to gun. Hereby is implied the fulfillment of a number of important independent conditions, no one of which may be overlooked in the effort to successfully accomplish the object sought. These conditions correspond to qualities possessed by a powder, and may be given, with their opposites, a general grouping under headings as follows:

TABLE II.

QUALITIES OF POWDERS.

	(1)	(2)	(3)	(4)	(5)
Positive.	Nonliability to detonation.	Development of minimum heat.	Formation of minimum residue.	Good keeping qualities	Maximum propulsive effect.
Negative	Detonation.	Erosion	Smoke and bore deposit	Decomposition	Low value of V/P

The first condition is of paramount importance and limits us to the employment of a colloid material. The second represents the fact that the greater the heat developed the greater the wearing away of the inner surface of the bore. The third requirement means obviation of bore deposit, which operates to reduce rapidity of fire by necessitating more or less frequent sponging, and to diminish accuracy of practice through the formation of smoke. The fourth requirement, stability, is all-important, when we remember that the ship must carry safely her store of powder for at least a cruise, and for the reason that when powders begin to decompose they lose their homogeneity and crumble—which means an end to regular pressure development.

Let us now take up requirement fifth—the attainment of maximum propulsive effect—and see what it leads to. What causes the expulsion of the projectile from the gun? The expansion of powder gases. What limits our employment of the expansive force of these gases? The attainment of the limiting bore pressure, this limit being commonly set at fifteen tons per square inch. What represents the greatest amount of work in the form of velocity? The greatest amount of gas expansion in the gun behind the projectile.

We desire, then, the greatest amount of gas expansion, but we are limited as to the rate of this expansion—that is, we must not let it develop in the bore a pressure greater than fifteen tons in the gun chamber or upon the interior walls of the piece. This is tantamount to saying that to produce maximum velocity we require the evolution, at a suitable limited rate of expansion, of the greatest possible volume of gas, the expansion of the gas constituting under these conditions the propelling impulse.

It may be stated here that we possess, *within limits*, the power of controlling the rate of combustion of colloid powders by varying certain conditions relating to combustion, the principal of which are (1) the size of the grains of which the charge is composed, (2) the volume of the powder chamber, (3) the length of the bore of the gun, (4) the weight of the projectile. Granting, then, that we possess within limits the capability of controlling the rate of evolution of the powder gases, we are led to the following conclusion: that the best smokeless powder is that stable colloid which, for a given weight of its substance, evolves in the bore of the gun at the most suitable rate of evolution and expansion the greatest volume of gas, the said evolution being accompanied with the development of the least heat.

We are led by this deduction to regard the action of the powder from a new standpoint. Besides considering what a powder is composed of, we must now consider what gases it is converted into upon decomposition and what volumes of these gases it generates. Most important of all, it leads us to conduct experiments for the purpose of ascertaining what colloid will, for a given weight of its substance, liberate the greatest volume of gases.

Here was one starting point for a series of experimental researches culminating in the discovery of an efficient smokeless powder. Another line of experimental approaches to the same end connected the efforts to toughen the substance of colloid films containing sufficient oxygen to effect their own complete combustion, with a view to the attainment of increased regularity in developed pressures; a third related to the determination of the causes of certain ballistic phenomena hitherto unexplained, *e. g.*, that acetone colloids developed, in some cases, greatly improven ballistic qualities after the lapses of periods of from six to twelve months from time of manufacture. These several lines of experimental investigation proved in the end to converge toward the attainment of a common result—the development of a special form of nitrocelluloid that possessed the toughness and therefore the regularity of burning of celluloid, and that contained enough oxygen to convert its substance, upon ignition, into wholly gaseous products—which the celluloid did not—and that liberated not only the greatest volume of powder gases at the most suitable rate, but the greatest volume of gases that can be evolved by any colloid at any rate of combustion, whether these colloids contained nitroglycerin, metallic nitrates, or other substances.

The questions now present themselves: in what ways do we possess the control of kind and amount of gases evolved upon the combustion of nitrocellulose and of its colloids ; how does the constitution of these gases vary ; what are they?

It has been already stated that the exact chemical formulæ for cellulose and its nitroderivatives have not yet been written. That for cellulose may be approximately expressed as $C_{6n}H_{10n}O_{5n}$, where n is an undetermined or indeterminate numerical quantity. When cellulose is steeped in nitric acid or in a mixture of nitric and sulphuric acid it is converted into the substance whose composition may be expressed as $C_{6n}H_{10n-an}O_{5n}(NO_2)_{an}$. These two expressions

$$C_{6n}H_{10n}O_{5n}$$
$$C_{6n}H_{10n-an}O_{5n}(NO_2)_{an}$$

may be considered in comparison with one another. Both contain the same quantity of carbon ; the amounts present of the other elements are changed by nitration ; *an* atoms of hydrogen are displaced by *an* equivalents of a combination of nitrogen and oxygen, (NO_2). This additional oxygen from the NO_2 acts to supply the energy that converts the cellulose into an explosive, and enters into its substance in combination with a certain amount of nitrogen. Why it carriers the nitrogen with it we do not know, but it is a chemical fact that it does so—the fact upon which the designation of the new explosives as nitroderivatives or nitro-explosives is based.

Upon the ignition of the nitrocellulose or its colloid the nitrogen is set free ; the hydrogen combines with its equivalent of oxygen and appears in the air as steam ; the remaining oxygen unites with the carbon to form gaseous oxides of carbon. If there be not enough oxygen to consume all the carbon into gas, part of the latter is deposited as soot ; this result was obtained in the attempt to employ celluloid as gunpowder. If there is enough oxygen to consume all the carbon into gases, we have, as products of combustion, a mixture of the gaseous oxides of carbon, of which there are two, CO_2 and CO. The property possessed by carbon of combining at high temperatures with intense energy with oxygen, to form gaseous oxides, is the fact upon which the practical development of explosives depends. There are many explosives that contain neither carbon nor oxygen, but with these we have as yet no practical relations in ordnance matters.

It has been stated already that the attempt to obtain what is called complete combustion for nitrocellulose colloids by incorporating oxidizing agents into them had misled investigators, who confounded the attainment of complete combustion with the development of maximum velocity at lowest pressure. "Complete combustion" means the conversion of all the carbon into the higher oxide of carbon—carbonic acid, CO_2—a dense gas about 1.9 time as heavy as the air, the formation of which is accompanied with the development of a high degree of heat. The complete combustion of carbon into carbonic-acid gas with the corresponding evolution of a great amount of heat is the characteristic of the combustion of nitroglycerin. The lower oxide of carbon, CO, is a gas much less dense than carbonic acid, possessing a density of about 1.4 times that of air. Suppose that we have a given weight of a compound of carbon and oxygen, with the elements taken in such proportions as to produce, on ignition, complete combustion into carbonic-acid gas, CO_2, with the accompanying evolution of a large amount of heat; let us also suppose that we have an equal weight of compound of the same elements in such proportions as to develop, on ignition, the lower oxide of carbon—carbonic oxide, CO; then, the latter compound, developing the lower oxide, would liberate a volume of gas nearly $1.9/1.4 = 1.36$ times greater than the former. The greater heat produced by the formation of the carbonic-acid gas would cause the volume of that gas evolved to be the more expanded, but, at the same time—and this fact is of crucial importance in the present work—the greater heat would cause the gas to be generated at *a more rapid rate*, in fact, at an extremely rapid rate; and what we require is a low, regular rate of gas evolution to prevent our exceeding at any time the set limit of permissible bore pressure.

In our effort to generate from colloid nitrocellulose the greatest volume of gas at the most gradual rate of expansion, we must seek, then, (1) to avoid the formation of CO_2 when CO may be formed in lieu thereof; (2) to avoid the formation of free carbon; (3) to generate the maximum amount of the lower oxide of carbon. If we give due consideration to the amounts of water and nitrogen formed simultaneously with the oxides of carbon, we shall find that the form of nitrocellulose developing the greatest amount of gas at the most suitable rate corresponds to the formula $C_{30}H_{38}(NO_2)_{12}O_{25}$, which breaks up on decomposition into $30\,CO + 19\,H_2O + 12\,N$.

This material is a new type of nitrocellulose,[*] developed by experiment to meet ballistic requirements, which contains just enough oxygen to convert its substance into a gaseous body. Its formation from cellulose depends upon strengths of nitric and sulphuric acid, temperatures of reaction and time of immersion of the cellulose in the acids from which the material is prepared. With ether-alcohol it forms a colloid that possesses, on the one hand, the toughness, and therefore the capability of development of regular pressures, of celluloid ; and on the other the capability of consuming into wholly gaseous products that characterizes the gun cotton-acetone colloid ; while as a powder it develops, with present types of guns, excellent values of V/P of about 2400/16. Briefly, it may be described as a celluloid containing enough oxygen to convert its substance (when it is consumed out of contact with the atmosphere) wholly into gaseous products.

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[*] This special form of nitrocellulose, which corresponds to a content of nitrogen of 12.44 per cent., and which was first developed in Russia by the eminent chemist, Prof. D. Mendeléef, has been independently developed at the Torpedo Station, through the study of effects of variation of times of immersion, temperatures of nitration and of washing, and strength of acids employed in the nitration of cellulose.

PART II.

It was stated in the preceeding paper [Part I] that the ballistic effect produced by a progressive explosive depended directly upon the volume of gas it evolved upon combustion, but was not directly dependent upon the attainment of complete combustion. Assuming total conversion from solids into gases and nonliability to detonation, pyrocellulose was shown to be the form of nitrocellulose best adapted for conversion into smokeless powder. As this material contains only enough oxygen to convert its carbon into carbonic oxide, CO—less than gun cotton, which converts its carbon partly into carbonic acid gas, CO_2, and partly into carbonic oxide, CO—the attainment of maximum efficiency from nitrocellulose was thus shown to be accomplished through a reduction from a maximum to a mean in the amount of oxygen capable of being incorporated into nitrocellulose.

On the other hand, it was stated that the incorporation of certain amounts of oxygen carriers (nitro-substitution compounds other than nitrocelluloses, such as nitroglycerin and nitrates of metallic bases) into colloid nitrocellulose led to the attainment of an increase in initial velocity of projectile for a given developed bore pressure. As nitroglycerin furnishes a surplus of free oxygen to aid in completing the combustion of the gases from the nitrocellulose, while the nitrates surrender oxygen on application of heat, it would appear in this case that the attainment of a more complete combustion led to improvement in ballistic effect.

We are thus brought face to face with a seeming contradiction —how, on the one hand, we must remove oxygen ; how, on the other, we must add oxygen to a progressive explosive in order to obtain maximum ballistic effect therefrom. In order to reconcile these apparently contradictory statements we must consider the manner of decomposition of the explosive in both cases.

One chief characteristic of pyrocellulose is its homogeneity. It represents no mixture of explosives and combustibles, such as are presented by other forms of powders, and it is converted directly by combustion into a set of gaseous decomposition products that may not be varied in amount and kind. Under these conditions the ballistic effect of the expanding gases from pyrocellulose may be referred to amount of charge, area of ignition surface, weight of projectile, caliber of gun, and volume of powder chamber. Other conditions affecting developed pressure and velocity are bore friction and resistance of the projectile to rotation through inertia.

The gun may be regarded as a gas engine in which the walls of the chamber and bore form the cylinder ; the projectile, the piston. The expanding powder gases perform work by imparting velocity to the projectile, whose inertia they overcome just as gas by its expansion in the cylinder overcomes the inertia of the piston and the parts linked thereto. In the engine the gas is admitted alternately, first at one end of the cylinder and then at the other ; in the gun it is admitted in rear of the projectile but once, so that the gun is an engine of a single stroke. In the engine the steam is admitted into the cylinder through a valve, and, after the lapse of a period of time less than that required for a full stroke, admission is cut off and work for the rest of the stroke is performed expansively ; in the gun the charge of powder constitutes both the gas itself and the valve that admits the gas ; for each grain of powder may be considered as a notch of opening of a valve—the more grains there are the greater the ignition surface, the greater the rate of emission of gas, or the greater the number of notches the valve is open.

The action of nitrocellulose powder gases in imparting motion to the projectile is that of the gas in the engine cylinder. The decomposition products are evolved at a high pressure and act to propel the projectile, just as the gas or vapor drives the piston in an engine. Thus far the two cases are in parallel ; they differ in that the space occupied by the gas in the gun is constantly increasing, both through the effect of the motion of the projectile along the bore and from the increase of chamber space due to the melting away of the powder charge, while space in the engine cylinder is increased through the motion of the piston and through connection with the valve before cutoff. As shown in

Table I, the ballistic value of gun cotton colloided in acetone (for a given gun) was $\frac{2100}{15-19}$; that of colloided soluble nitrocellulose, containing not enough oxygen to convert its carbon wholly into carbonic oxide, CO, was $\frac{2100}{16}$. Under similar conditions of firing, pyrocellulose developed a value of $V/P = \frac{2400}{16}$. It may be urged that the ballistic superiority of the latter colloid as compared to the two former is not wholly attributable to character and amount of evolved gases, as the acetone colloid is brittle, and that prepared from soluble nitrocellulose is somewhat brittle and is deficient in oxygen, while pyrocelluloid is of a tough, leathery consistency, capable of withstanding high pressures without premature disintegration. Nevertheless, as these colloids prove inferior to the pyrocolloids for lower pressures of about 10 tons per square in., at which the effects of brittleness are not perceptible, and for which they all afford pressures regularly proportional to developed velocities, it remains that magnitude of volume of evolved gases is a factor of prime importance in the attainment of ballistic efficiency.

COMPOSITE POWDERS.

The results of incorporating an oxidizing agent or oxygen carrier into colloids merit special study. Suppose that a given nitrocellulose be colloided and formed into strips of a number of definite thicknesses. If these strips be collected separately and dried, we may prepare from them series of rounds, each series composed of different weights of strips of some one thickness. If the length and breadth of the strips be great in relation to their thickness, we need consider only the latter element of dimension in relation to their mode of combustion. *

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* We have (Glennon, Interior Ballistics, Chapter VI, pp. 59-60)

$$“\phi(y) = \alpha y(1 - \lambda y + \mu y^2 \ . \ . \ . \ .),$$

where y is the fractional part of the least dimensions of the grain burned up to any moment; $\phi(y)$ the fractional part of the whole grain burned up to the same moment; and α, γ and μ constants depending upon the form the grain.

If the grain be a rectangular parallelopiped with a square base, and the altitude as the least dimension, we have

$$\alpha = 1 + 2x \qquad \lambda = \frac{2x + x^2}{1 + 2x}, \qquad \mu = \frac{x^2}{1 + 2x},$$

where x is the ratio of the altitude to the side of the base.”

Applying the above to the present case, we find that if the altitude be considerably diminished (x approaches zero) we have the case of the thin plate, and that the constants approach the values

$$\alpha = 1, \qquad \lambda = 0, \qquad \mu = 0,$$

or $\phi(y) = y$.

Upon firing series of rounds of the several powders from a given gun we obtain the following results as to the manner of explosive action :

1. Strips of over a certain mean thickness will be only partly consumed in the bore; the unconsumed remnants will be projected burning from the gun, to be quenched in the cool outer air, where they fall unconsumed to the ground and may be picked up at various distances from the piece in front of the muzzle, possessing the original form (in reduced dimensions) of the grains of which the charge was originally composed. Such powders develop low bore pressures and afford low muzzle velocities. In point of work performed they are equivalent to smaller charges of quicker powders. It may be remarked that no work is done in raising the temperature of the unconsumed portions of the grains, for if the temperature of the latter be raised but a few degrees, the ignition point of the explosive is reached and its substance would wholly disappear.

2. Strips of under a certain mean thickness are totally consumed in the gun. They develop high pressures for low velocities. The thinner the strips the less the weight of charge required to develop the limiting permissible pressure, on account of the greater initial surface presented by the thinner strips, which occasions a high initial gas development.

3. A certain mean thickness of strip will be found, for which, at a set limit of pressure, a minimum weight of powder will develop the greatest velocity that can be developed at that pressure. If strips of other thicknesses develop practically identical velocities and pressures for the same pressure limits, it will be by burning greater weights of powder. Such a powder may be designated a maximum powder, for the material from which it is prepared and for the gun from which it is fired.

Suppose, then, that colloided gun cotton of nitration $N = 13.3$ develops in a given gun a maximum value $V/P = \frac{2100}{15}$, what will be the effect of incorporating into such powder a certain amount of nitroglycerin, or of metallic nitrates such as barium and potassium nitrates? Assume that during the process of colloiding the requisite amount of nitrates be uniformly incorporated throughout the substance of the pasty mass, which is subsequently formed into strips as before. For this material we shall find that the maximum powder develops a value of $V/P = \frac{2400}{15}$,

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But y depends alone on the thickness of the plate, therefore the speed of combustion of a plate is a linear function of its least dimension.

as against $\frac{2100}{15}$ for the pure colloid, a gain in velocity of 300 foot-seconds for a given pressure; in energy, $\left(\frac{mv^2}{2g}\right)$, of about 30 per cent.

If in lieu of nitrates we incorporate nitroglycerin into the colloid, we will obtain a pasty mass that can be worked conveniently into the form of rods or cords, whence the name cordite, applied to one of its best-known types. Cordite, as used in England, consists of

Nitroglycerin	58 parts.
Gun cotton	37 parts.
Vaseline	5 parts.

Such a powder, fired under the above conditions, develops a value of $V/P = \frac{2400}{15}$, approximately.

There is one characteristic of powders containing nitrates such as the K and the French BN, to which attention is to be directed. The nitrates contained in these powders exist in them in a state of suspension, in an undissolved state. For the BN the microscope reveals minute crystalline particles uniformly disseminated throughout its mass; the barium nitrate employed in the K powder is insoluble in the colloiding agent, acetone, and is also insoluble in the colloid, in which it is held in a state of suspension and of uniform distribution.

In the case of the nitroglycerin powders it is known that the nitrocellulose is not in true solution in the nitroglycerin. In this connection the following quotation from an authority upon nitroglycerin powders, Mr. Hudson Maxim, may be cited;

"In the very early smokeless powders, especially those made of compounds of soluble pyroxylin (gun cotton) and nitroglycerin, was supposed that the nitroglycerin actually held and retained the pyroxylin in solution, but it has since been learned that the nitroglycerin is held by smokeless powders, whether made from high or low grade gun cottons, in much the same manner as water is held by a sponge: in fact the pyroxylin exist in smokeless powders in the shape of a very minute spongy substance, and the nitroglycerin is held in a free state within the pores of this sponge.

"It is possible, even with powders containing as little as 25 per cent. nitroglycerin, to squeeze out the nitroglycerin in a pure state by subjecting a piece of this powder to great pressure between smooth steel plates."

The amount of nitro carrier (nitrate or nitro-substitution compound other than nitrocellulose) considered necessary to the production of good ballistic results, as exemplified in certain known powders, may be tabulated as follows :

TABLE III.

Variety of powder.	Nitro-carrier used.	Per cent. of nitro-carrier in given weight of powder.
Cordite.	Nitroglycerin..............	58
Maxim..	Nitroglycerin.....	10 to 25
BN............	Barium and potassium nitrate..........................	21 to 25
K..............	Barium nitrate............	14.25

The composition and ballistic properties of the three classes of explosives—pure colloids, colloids containing metallic nitrates, and colloids containing nitroglycerin—may be compared as follows :

TABLE IV.

Variety.	Pure colloid.	K	BN	Cordite.
	Gun cotton . 85.00 Soluble nitrocellulose . 10.00 Sodium carb. 1.00 Solvent resins, etc. . 4.00 100.00	Gun cotton & soluble nitrocellulose, balanced . . . . 84.25 Barium nitrate . . . 14.25 Calc. carb . . 1.50 100.00	Insol. nitrocellulose. . . . . . . 38.67 Soluble nitrocellulose. . . . . . . 33.23 Barium nitrate . 18.74 Potassium nitrate 4.54 Calc. carb . . . . 3.65 Volatile. 1.29 100.12	Nitroglycerin . . 58.00 Gun cotton . . . 37.00 Vaseline . 5.00 100.00
Type.	Pure colloid.	Metallic nitrate.	Metallic nitrate.	Nitroglycerin.
Manner of incorporation of oxygen carrier.	. . . .	Solid undissolved particles, uniformly distributed throughout colloid matrix.	Solid undissolved particles, uniformly distributed throughout colloid matrix	Undissolved particles held in suspension, as water in sponge.
$\frac{V}{P}$	$\frac{2100}{15\text{-}19}$	$\frac{2400}{15}$	$\frac{2400}{15}$	$\frac{2400}{15}$

Remembering what has been said in relation to the ballistic performance of the varieties of powders cited, we are led to the following conclusion :

That minute particles of an oxygen carrier uniformly incorporated into a nitrocolloid and held in suspension in an undissolved state throughout the body of the same, render more progressive the combustion of the nitrocolloid into which they are incorporated.

For convenience of reference, I shall refer hereafter to the oxygen carrier held in suspension in the colloid as the *accelerator.*

Viewed in the light of the principle here enunciated, the several powders that we have been considering are all similar variants of the purè colloid. The remark of the compounder, that " a little nitroglycerin certainly does help the powder along," is now the more readily comprehensible.

The methods commonly employed for co-ordinating natural species may be applied, by way of illustration, to the classification of the various types of progressive explosives, to establish their relations to one another, and to indicate the lines along which advance has been effected.

We shall next consider how the accelerator acts to develop increased velocity without developing increased pressure.

1. It has already been shown how it is possible with powders, containing as little as 25 per cent. of nitroglycerin to squeeze out the nitroglycerin in a pure state by subjecting the powder to great pressure between smooth steel plates.

If it be possible to extract nitroglycerin by application of pressure from powder in which it is incorporated, then there will be a tendency to flow in the direction of least pressure from the instant of ignition of a charge to that of its complete combustion. This would mean, first, flow from within outward in the gun chamber, where a relatively large proportion of the nitroglycerin would be consumed ; second, flow in the direction of the windage, where the amount of nitroglycerin consumed would also be relatively great. Such action accounts for the rapid erosion of the surface of gun chamber and rifled bore when powders containing nitrogylcerin are employed.

2. The eminent Russian chemist, Professor D. Mendeléef, developer of smokeless powder in Russian, in a paper upon pyrocellulose powder, says :

" The chemical homogeneity of pyrocollodion plays an important part in its combustion, for there are many reasons for believing that upon the combustion of those physically but not chemically homogeneous materials, such as nitroglycerin powder (ballistite, cordite, etc.,) the nitroglycerin is decomposed first, and the nitrocellulose subsequently in a different layer of the powder. The experiments of Messrs. T. M. and P. M. Tcheltsov at the Scientific and Technical Labortory show that for a given density of loading the composition of the gases evolved by nitroglycerin powders varies according to the surface area of the grains (thickness of strip), a phenomenon not to be observed in

TABLE V.

Family.	PROGRESSIVE EXPLOSIVES.										
Genus.	Agglomerated powders.		Pure colloids.					Accelerated colloids.			
Species.	Black gunpowder.	Brown powder.	Acetone colloids (experimental, for small arms).	Pyrocellulose—United States, Russia, France.	Acetic ether colloid—Wetteren	Ether-alcohol, with or without insoluble nitrocelluloses incorporated.		Acetone colloid; nitroglycerin accelerator. Cordite, Ballistite, Maxim.	Acetone colloid of blended nitrocelluloses; barium nitrate accelerator. K.	Ether-alcohol colloid; barium nitrate and potassium nitrate accelerator BN France.	Gun cotton colloided with nitrobenzols. MN. Rifleite.
Subspecies.	Various mixtures of charcoal, saltpeter, and sulphur.	Various mixtures of charcoal (partly charred and containing oxygen), saltpeter, and sulphur.	Colloids of insoluble and soluble nitrocelluloses.	Poudre B—France. *	Gun cotton, with or without soluble nitrocellulose.	From nitrocellulose.	From nitrohydrocelluloses.	Various proportions of nitroglycerin in nitrocelluloses.	Various proportions of nitrocelluloses and nitrates.	Various proportions of nitrocelluloses and nitrates.	*Rifleite*; nitrocellulose colloided in acetone, with or without dinitrobenzol. Gun cotton colloided with mononitrobenzol.
Classification letter.	A.	B.	C.	D.	E.	F.		G.	H.	I.	J.

* The first rational smokeless powder, developed in France by the eminent savant, M. Vielle.

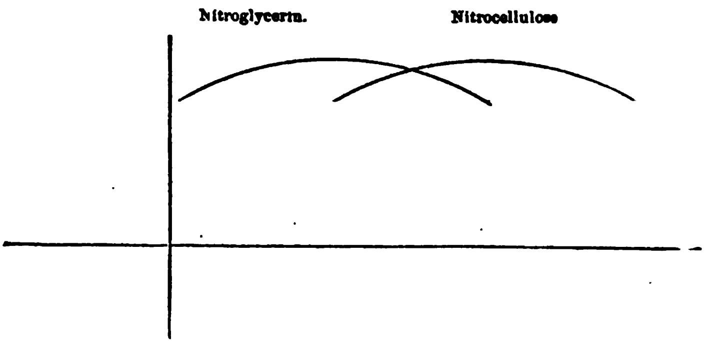
the combustion of the pyrocellulose powders. There is only one explanation for this, viz: that the nitroglycerin, which possesses the higher rate of combustion (Berthelot), is decomposed sooner than the nitrocellulose dissolved in it. This is the reason why nitroglycerin powders destroy the inner surfaces of gun chambers with such rapidity."

We conclude from the above that the nitroglycerin incorporated into a colloid burns more rapidly than the nitrocellulose forming the colloid. More nitroglycerin is consumed with one part of the charge than with another. During the first period the products of combustion evolved in chamber and bore are largely those of nitroglycerin; during the second, those of nitrocellulose.

Moreover, as both materials exist in an uncombined state, although in one of intimate admixture; as both decompose wholly into gases, while each contains sufficient energy to continue its own decomposition, once that decomposition is begun, there is no reason why the rates of the two decompositions should be equal; it would rather appear that each substance should decompose at the rate peculiar to itself, as far as it was able, under existing conditions of heat and pressure, to effect a separation of its substance from the mixed mass of the powder.

Conditions point, therefore, to there being two intervals in the decomposition of the charge, during one of which a maximum amount of nitroglycerin, and during another a maximum amount of nitrocellulose is burning.

In what follows it is not intended to attempt more than to indicate mode of progressive combustion as implying the superimposition of maxima and minima of effort. This may be represented graphically in the present case as follows:



The result of the combination of the conditions here indicated would be the imparting of a double impulse to the projectiles due to the successive occurrence of two maxima of acceleration. Considered as to their limit of possible range, the successive impulses may occur incrementally, so that the accelerator may be expressed in the form

$$\varphi(p')\frac{d^2p'}{dt^2}+\varphi(p'')\frac{d^2p''}{dt^2},$$

Where p' represents the pressure due at any instant to the combustion of the nitroglycerin, p'' that due to the nitrocellulose.

The projectile may be regarded as receiving a third impulse, resulting from chemical combination of the gases evolved by the nitroglycerin and the nitrocellulose. According to the researches of Messrs. Macnab and Ristori (*Proc, Royal Soc.*, Vol. LVI, p. 8), the decomposition products of nitroglycerin are

CO_2	CO	CH_4	O	H	N	H_2O
57.6	—	—	2.7	—	18.8	20.7

And from the same source we obtain the decomposition products of nitrocellulose ($N = 13.3$) as

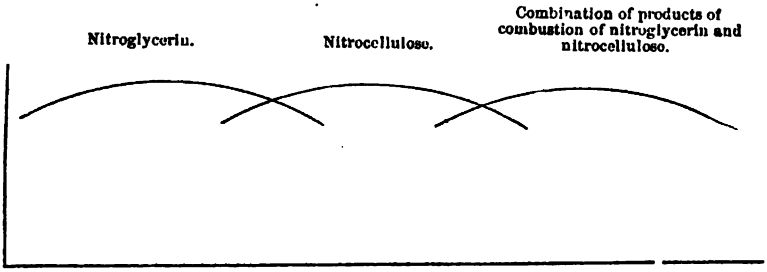
CO_2	CO	CH_4	O	H	N	H_2O
29.27	38.52	0.24	—	0.86	13.6	16.3

What may be called the third impulse would represent the combination at a high temperature of multiples of decomposition products developed in the ratios

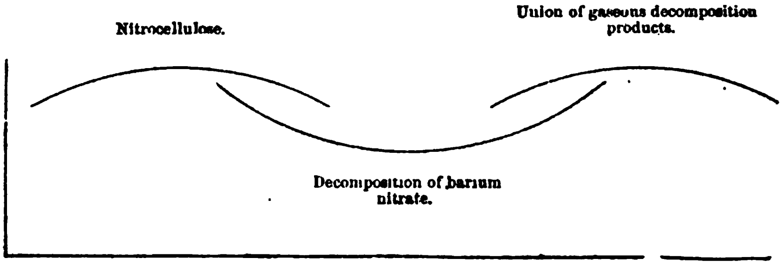
$$A\begin{bmatrix} CO_2 & CO & CH_4 & O & H & N & H_2O \\ 57.6 & — & — & 2.7 & — & 18.8 & 20.7 \end{bmatrix}$$

$$B\begin{bmatrix} 29.27 & 38.52 & 0.24 & — & 0.86 & 13.6 & 16.3 \end{bmatrix}$$

These phases may be indicated graphically as follows:


Nitroglycerin.
Nitrocellulose.
Combination of products of combustion of nitroglycerin and nitrocellulose.

Accelerated colloids of K and BN types containing metallic nitrates are next to be considered. We may assume that the nitrocolloid into which minute particles of a nitro carrier of this type are cemented itself burns in approximation to the law of decomposition of the colloid. This state of affairs is similar to, though not identical with, the preceding; in the former, both nitroglycerin and nitrocellulose are able to effect their own decomposition, evolving gases that recombine; in the latter, the nitrocellulose alone possesses this property, the metallic nitrates surrendering their oxygen through the effect of heat developed during decomposition of the colloid. The successive reactions may be represented as follows :


Nitrocellulose.
Union of gaseous decomposition products.
Decomposition of barium nitrate.

Instead of three maxima of effort there are two maxima and one minimum, the maxima representing the combustion of the nitrocellulose and the subsequent combination of the gases therefrom with the oxygen of the barium nitrate; the minimum, the absorption of heat expended in decomposition of the barium nitrate.

A comparison of the diagrams shows that the processes of combustion in the case of colloids containing nitroglycerin and of those containing metallic nitrates are similar. Both represent aggregates of work resulting from successions of independent decompositions. For such powders an element of time enters into our conception of chemical action; what the ultimate products of combustion are depends upon the order of occurrence of successive evolutions of various volumes of different gases at high temperatures. *

The base of the projectile is subjected to a series of impulses due to the development of successive waves of pressure; the result is an increased initial velocity for a given developed pressure, the acceleration being sustained throughout a comparatively longer period of time.

Those familar with experimental development of ordnance during recent years remember a type of multicharge gun whose construction seemed based upon a favorable combination of correct principles, but which was rejected on trial, as its practical disadvantages were found to outweigh by far its advantages. I

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* See extract from paper by Professer Mendeléef, p. 172.

refer to the Lyman-Haskell multicharge gun, a weapon supplied with a number of pockets distributed along the axis of the bore. In each pocket a charge of powder was placed ; it was supposed that the projectile, by uncovering successive pockets in its flight, would cause their contents to ignite and thus furnish successive accelerating impulses to increase its velocity.

From what has been already said in relation to the principle of successive combustion, it will be seen that the employment of charges of accelerated powder, like those above described, in a gun of present-day type, represents the limiting extension of the multicharge principle. In relation to the successive combustions, the nitroglycerin and the nitrocellulose may be considered as subcharges, contained in independent chambers or pockets, or distributed throughout a very large number of small pockets.

The principle already stated, as established by the study of the ballistic action of accelerated or composite powders, may be now amplified as follows :

Minute particles of an oxygen carrier, uniformly incorporated into a nitrocolloid and held in suspension throughout the mass of the colloid in an undissolved state, act through their independent combustion in such a manner as to render more progressive the combustion of the colloid into which they are incorporated.

ANNUAL REPORT OF MAJOR-GENERAL MERRITT, U. S. ARMY, COMPRISING REPORT OF MAJOR J. P. STORY, 7TH ARTILLERY, DEPARTMENT ARTILLERY INSPECTOR.

HEADQUARTERS DEPARTMENT OF THE EAST.
Governor's Island, New York City,
August 25, 1899.

The Adjutant General,
U. S. Army,
Washington, D. C.

Sir :

I have the honor to submit report of the operations and affairs in this department since September 13, 1898, the date of the report of Brigadier General George L. Gillespie, U. S. Volunteers, then commanding the Department.

I resumed command of this Department January 7, 1899, since which time most of the Infantry and Cavalry in the Department have been ordered on foreign service, leaving at the present date only four troops of Cavalry and three companies of Infantry.

The reports of the department staff officers are complete as to the operations and condition of affairs within the several responsibilities, but the questions raised in the report of the Artillery Inspector call for rather extended comment.

Since resuming command of this Department last January, I have inspected the Artillery posts at Fort Monroe and Washington Barracks. It is my intention, as soon as possible, to inspect other sea-coast forts, probably during their coming season of target practice with heavy guns.

I have no specific recommendations to make regarding any one place. I know the officers to be intelligent, industrious, and zealous in their efforts to improve the efficiency of their commands. That the coast artillery is not to-day in an efficient condition is due to causes over which artillery officers have no control ; nor can these impediments be reached by the Department Commander. Some require the action of the Secretary of War, and others can be remedied only by Congress.

The needs of the artillery are most ably presented in the report herewith of the Department Artillery Inspector, to which I invite attention. I do not feel myself called upon to urge the specific remedies which he proposes, but I certainly coincide with the opinion he expresses that the artillery is in need of remedial legislation. I deem it my duty to call attention to the defects which Major Story treats in detail, and then leave the question of how they shall be removed to the law making authorities and their advisers.

Our cavalry and infantry to-day are organized on a modern basis, are splendidly officered and equipped, and, with regular supplies of food, clothing and ammunition, contain within themselves the elements of complete efficiency. This is not true of the artillery ; the officers are well educated and zealous, but their efforts are cramped by an imperfect organization, and responsibility for the efficiency or inefficiency of their arm lies, not as it should, with themselves, but very largely in other quarters.

Either through defects of law or their own inefficiency, the supply departments upon which the artillery is wholly dependent, have frequently failed to loyally and energetically serve its interests. The fact that the Enginer Department working under the same laws, has, under its present chief, given the artillery no cause for complaint, would seem to indicate that something is wrong besides the law.

This condition gives rise to the often expressed desire of the artillery for a chief of that arm who would see that it is supplied with what it needs to be effective ; but I personally have very grave doubts as to this being the most suitable remedy, as it may result only in adding another bureau to the War Department, which it may be as difficult to make efficient as some of those already in existence.

I desire, in addition, to call especial attention to the following points in the report of the Artillery Inspector :

1. The failure of the Quartermaster's Department to make timely provision for housing the garrisons at new artillery posts.

2. The necessity for providing at artillery posts a permanent post non-commissioned staff of specialists, *i. e.*, electrician and observer sergeants.

3. The recommendation that the strength of the coast artillery be fixed at the number of officers and men required to fully man the guns.

It is also observed that the artillery should be inspected by artillery officers; and the fact that the Department Commander's Artillery Inspector has no power to inspect, is a patent absurdity, and one which I urge may be disposed of at an early date.

The means of making any arm of the service all it should be, should rest with the general commanding the geographical department in which said arm of the service is stationed.

Very respectfully,
WESLEY MERRITT,
Major General, U. S. Army,
Commanding.

REPORT OF MAJOR STORY, ARTILLERY INSPECTOR.

HEADQUARTERS DEPARTMENT OF THE EAST,
Office of Artillery Inspector,
Governor's Island, New York City, August 10, 1899.

Adjutant General,
Headquarters Department of the East,
Governor's Island, New York City.

Sir:

In compliance with your letter of the 21st ult., I have the honor to submit the following report as the Inspector of Artillery of the Department.

In 1898 Major William Crozier (Captain Ordnance Department), Inspector General, U. S. Volunteers, made an extended inspection of the fortifications on the Atlantic Coast. This inspection, made during our late war with Spain, was to determine the condition of the new armament in our forts and the efficiency of the personnel manning the armament. His general report, summing up his inspections, is published in Circular No. 7, 1899, Headquarters Department of the East.

The report states as a general conclusion "it cannot be said that the artillery defence is, or has been recently, in any but an inefficient state."

Major Crozier is a zealous and able officer, a recognized expert in ordnance construction, and the honesty of his opinions cannot be questioned. If, however, his conclusion be just, he has not, in my judgment, discovered the root of the evil and placed the responsibility where it belongs. He finds at one post a very efficient garrison, at another the reverse. In either case, the measure of efficiency is determined by the zeal and ability, or want of these traits, in the immediate commanding officer. There is no one person in our army who is responsible for the efficiency of the artillery for the whole service. There is no officer, who, a master of artillery knowledge, can prescribe a standard of efficiency and have the power to enforce it in all our artillery garrisons.

It is evident that Major Crozier sees the necessity of a head to the artillery, since he says in his report: "I would suggest that there should be on the Staff of the Commandant of the Army a Chief Inspector of Artillery, * * * * As a concise statement of what is in my opinion necessary to rehabilitate the artillery service, I will say that their great needs are * * * * frequent, vigorous and skillful inspection."

Since the installation of the modern armament, I have seen only two inspections of any special value from the artillery standpoint, those of Majors Duvall and Crozier, *late* Inspector General, U. S. Volunteers, one an artillery the other an ordnance officer, both most competent, whose services were utilized in the emergency of our late war with Spain to learn the actual condition of forts, armament and personnel. These inspections were both ordered by the Secretary of War. The reports resulting from these inspections gave the War Department, for the first time, the real state of every emplacement, gun carriage and gun of the modern armament inspected by them.

In each Military Geographical Department in which there are the headquarters of one or more regiments of artillery, the Army Regulations provide for an artillery officer on the Staff of the Department Commander, who is styled The Artillery Inspector. The Department Commander is not only without authority to send this officer to inspect the personnel and materiel of the artillery posts in his command, but is prohibited by law from so doing. This officer is available for almost any military duty except that of artillery inspection. In no Military Department may its Commanding General select for the purpose and send an officer, under his command, of sufficient professional qualifications to duplicate the inspections of Majors Duvall and Crozier.

It is no reflection on the accomplished officers who compose the Inspector General's Department to say that no officer in that corps has the qualifications as an artillery and ordnance expert to reproduce the inspections of the officers just named.

I cannot find outside of the United States a service in the world where inspections of coast artillery are made except by artillery officers. Coast artillery is to-day so "technical and scientific" in its materiel and in the specific duties of its personnel that it ought not in its technical or scientific character be subject to inspection except by an artillery expert, and I do not know where such officers can be found in our Army, except in the Ordnance and Artillery itself. A. R. 868 prescribes "All depots, armories, arsenals, and public works of every kind under charge of officers of the Army * * * * will be inspected annually by officers of the Inspector General's Department. These inspections will include military and business administration and methods, but will not extend to the scientific or technical character of the work * * ." Artillery should be exempt in "the scientific or technical character of its work" from inspection by officers of the Inspector General's Department as are now Engineers and Ordnance.

The reasons for relief from such inspections are similar and equally convincing for the three branches. It is certainly injudicious to follow a system of inspection in peace which must, as in our recent experience, be thrown over in war.

It may very pertinently be asked if the Artillery in the Department of the East, and more than half of the artillery in the United States is in this department, is more or less efficient than in 1898. The Department Commander has asked me this same question, but, I could not give him a conclusive answer, because, as before stated he is without authority to send an officer with efficient professional qualifications to ascertain the actual condition of the artillery under his command. However, since Major Crozier's inspection two of the five artillery regiments in this Department have been removed, in the meantime the enlisted strength of a battery has been reduced from two hundred men to one hundred and twenty, and, in addition many new fortifications have been turned over by the Engineer Department for occupation by artillery troops. An increase of work with less men to do the work seldom lends itself to an increase of efficiency.

A high English authority has said that a position finder multiplies several times the value of any gun to which it is applied. In other words, this statement means that with correct position finding, one gun will do the work of three or four where the pointing is based on individual judgment, however skilled it may be.

The whole object of the Artillery is TO HIT. No man can be so well instructed in estimating distances that his judgment is of much value for ranges in a harbor beyond 3000 yards, and in the open sea the limit is much less.

The average cost of an emplacement with its gun and carriage, as estimated, is for:

The 12-inch B. L. Rifle, disappearing carriage,	$141,027.
The 12-inch B. L. Rifle, barbette carriage,	118,787.
The 10-inch B. L. Rifle, disappearing carriage,	99,255.
The 10-inch B. L. Rifle, barbette carriage,	74,155.
The 8-inch B. L. Rifle, disappearing carriage,	72,090.
The 8-inch B. L. Rifle, barbette carriage,	55,565.

When constrasted with the cost of a fire control and direction equipment, these figures clearly show the immense savings effected by range or position finding devices. The demoralizing effect of a hit as compared to a miss cannot be reduced to a money value. The cost of a miss with an armor piercing projectile is for the 12-inch rifle $561.70; for the 10-inch rifle $322.40; for the 8-inch rifle $164.65.

The average cost of an emplacement for the 12-inch B. L. Mortar with its gun and carriage is estimated at $32,600, and since the object to be fired at cannot be seen from the mortar pit, a mortar battery without a system of position finding is as useless as a rubbish heap of sand and iron.

The statements just given show how indispensable is an accurate range and position finding system, yet, what is the condition of that system to-day, which Major Crozier found so inefficient in 1898?

It may be said that not one of the 12-inch mortar batteries is properly equipped with position finders for war service. Some have improvised systems which have been used in carriage tests and target practice; some have the "emergency" position finder (type B) which is used at the battery itself, but, in most instances, the whole field of fire cannot be seen from the battery, and in many instances, the mortar battery is so screened that no part of the field of fire is seen from it. Some mortar batteries even have no equipment for position finding, yet, 12 inch mortars form one half our armament of guns of heavy calibre. There is, as a rule, a better condition with our batteries of breech loading rifles, yet in not a single Fire Command in the United States is there the complete equipment for position finding, control and direction of fire contemplated in the Drill Regulations as approved by the Secretary of War.

Who is responsible for this condition of affairs?

Major Crozier in his report, after drawing particular attention to the neglect of providing a system for pointing mortars, makes a statement, which, from his standpoint, applies to the subject of position finding for all our modern batteries: "The matter has not been in charge of any executive bureau of the War Department, and the responsibility for proper installation has been turned over to various bodies which have not been organized with reference to the conduct of executive work. The subject has been confined to the Artillery branch of the service, but this action thus far has not resulted in obviating the difficulties."

If this statement of Major Crozier be accurate, the responsibility for the inefficient condition of fire control and direction is clearly fixed upon the Artillery, and there is no evading such responsibility.

But let us examine the record. By General Orders, No. 107, A. G. O., 1798, the Secretary of War to provide for "the active installation of range and position finders" divided the supply of materials between the three following bureaux, Engineer Department, Ordnance Department, and Signal Department. This order distinctly specifies the materials each bureau is to furnish, and there is not a word in it which in any way connects the Artillery with the installation of range and position finders. To-day, as then, the utmost any artillery officers can accomplish toward the inauguration of the approved system of fire control and direction is limited to the asking. The supply of material and the work of installation belong to the three bureaux named in the order before cited.

On whom does the responsibility for a failure of a proper system of position finding rest?

There is a divided responsibility in which I hold the artillery has no share, so that the exact responsibility can be fixed on no one. It would perhaps be just to say a great part of the fault is due to the defective organization of the artillery, and does not attach to any individual.

The correspondence in this office shows the Chief of Engineers has not only been willing to do all that devolves upon him in this connection, but time and time again has made suggestions and recommendations to expedite the work. The Chief Signal Officer and the Chief of Ordnance always express a willingness to do all that is required, yet the work lags and lags to such an extent that not a single artillery fire command in the United States is properly equipped. The present condition could not have existed if there had been a chief of artillery to say with authority exactly what is needed, and then see that the equipment is supplied, or, in the event of failure, to fix the responsibility. Under the present system there is confusion, and confusion in administration will inevitably remain until the artillery has a head.

It has been wisely said by an English authority that an artillery personnel cannot be improvised in time of war. It requires, to become efficient, long sustained and careful training in time of peace.

The lack of a sufficient force, properly trained, to care for the modern armament and to man our new forts is a serious menace to artillery efficiency. We do not have to go back to ancient history for an example. At the beginning of the late war with Spain, naval experts in Europe generally believed, basing their judgment on the published data of the war vessels, that the Spanish Navy was superior to our own. In the Spanish Navy as in our Artillery there was the modern armament but an inadequate personnel trained to man the guns. Spain's policy, in this respect invited the disaster which was meted out to her.

To illustrate the insufficiency of troops supplied, as compared withe th number required for the actual service of the armament, let us take a single harbor, Portland, Me., and state the personnel needed to man the guns now mounted or provided for. In this estimate, based upon the Drill Regulations for the coast artillery, there will not be a single officer or man without definite duties, in other words, not a person for reserve, or guard or for the sick. For the defence of this harbor there should be, assigning the appropriate grade for each duty:

One Fortress Commander, a Colonel.
Two District Commanders, Lieutenant Colonels.
Six Fire or Mortar Battery Commanders, Majors.
Two Captains on Fortress Staff.
Two Lieutenants on District Staff.
Thirteen Captains of batteries.
Thirteen 1st Lieutenants of batteries.
Thirteen 2d Lieutenants of batteries.
One thousand one hundred and twenty-four enlisted men.

Please compare this with the actual conditions on the 30th of June. The garrison for the artillery defence of this harbor was then one captain, one 1st Lieutenant, and one 2d Lieutenant, and one hundred and twenty-nine men, and one of the most important approaches to the inner harbor is without a soldier to guard it. There is no artillery available to remedy this state of affairs, yet this harbor is only one day distant from the naval station at Halifax. It has an unusually powerful armament with the meagre personnel just indicated to serve it. The Chief of Engineers and the Chief of Ordnance have done their share of the work in providing emplacements and armaments, and have done it well, yet, to-day, if war were declared, this port is a tempting prey to seizure. Neither here nor elsewhere would there be so inadequate a personnel if there had been a chief of artillery to urge that the personnel should keep an equal pace with the armament.

The Artillery service has been and is now being continually crippled by the large number of enlisted men who, upon discharge, either leave the service or re-enlist in the Infantry or Cavalry, where they receive the same pay as in the Artillery, and for much less exacting work. The Artillery, a few years since, was a favored branch of the service with the soldier, but the conditions are now so changed that it is seldom that he will re-enlist. The artillery soldier has to be drilled and instructed as infantry, and has to take the same care of his infantry equipments as the infantry soldier, in addition has artillery drill and instruction, and of late, in many instances, his regular duties have been increased by the labor of transporting, assembling and mounting of heavy gun carriages and guns.

In my report last year I drew attention to the high grade of intelligence required in the artillery soldier, and to the unusual amount of work at present imposed upon him, and I urged that he should receive the pay and classification of soldiers in the Engineer Corps and in the Ordnance Department. This recommendation, I renew.

The Act of March 2d, 1899, provided two mechanics for each heavy battery of artillery. Requisition for tools intended to make the act effective have failed both in the Quartermaster's Department and in the Ordnance Department. The inertia of those two Departments have thus far defeated, in part, the object of the legislation.

The orders of the War Department and Army Regulations clearly direct that the Ordnance Department shall supply the blanks needed for artillery target practice. This practice season is now at hand, but in all cases of record in this office, applications for these blanks have been refused by the Chief of Ordnance.

Another matter to which I wish to invite attention is the apparent attitude of the Quartermaster's Department in the construction of proper barracks and quarters at the new artillery posts, which attitude from an artillery standpoint is most unsatisfactory. In the spring of 1898 artillery troops were ordered to take station at Fort Williams, Maine, Fort Constitution, N. H., Fort Strong, Mass., Fort Greble, R. I., Fort DuPont, Del., Fort Mott, N. J., Fort Hunt, Va., Fort Washington, Md., and Fort Caswell, N. C. Although fortifications for these posts were one or more years under construction, yet in no case did the Quartermaster General anticipate the arrival of troops by the building of quarters, barracks and storehouses, and though the stations mentioned were occupied in the spring, it was not until late in the autumn that even the so-called "temporary shelter" was provided.

This temporary shelter is a wretched makeshift for proper quarters, and on account of its perishable quality such quarters are very uneconomical to the Government at posts where permanent buildings must be constructed at a later date.

This year artillery troops were ordered to the new posts at Fort Rodman, Mass., Fort Michie, N. Y., Fort Armistead, Md., and North Point, Md., and it is feared the unfortunate experience of last year, with respect to delay in housing them may be repeated. Also there has seemingly been an unjustifiable neglect on the part of the Quartermaster General in providing a proper and sufficient water supply at some of the new artillery posts. So far as the artillery is concerned, I cannot see that the Quartermaster General ever anticipated their needs and provides for them though the places where shelter and water will be required can be readily ascertained years in advance of the time of occupation by troops.

I expect later to submit a report for action which will go into this subject more in detail.

I wish also to submit for consideration a suggestion which, if carried into effect, will save the Government large sums of money. It is that when the Engineer Department buys ground for fortification it should also buy enough for the location of the barracks, quarters and other buildings to be constructed by the Quartermaster's Department. For this purchase the Quartermaster's Department should re-imburse the Engineer Department so that the additional land needed for quarters may not be a charge against the Engineer appropriation.

Under the present practice, the Engineer Department as a rule only buys ground for the fortifications it has to construct with the result that if more land is required, advantage is taken of the need of the Government and excessive prices paid, or else the public buildings are constructed on too limited ground.

By the Act of March 2d, 1899, provision was made for one electrician sergeant at each artillery post where there were electrical appliances. While this was a judicious step towards establishing a post non-commissioned staff of specialists which will be independent of the batteries, yet, it did not go far enough, since it is equally important to have skilled observers for the principal instruments used at the commanders stations for position finding, and the control and direction of fire. The effectiveness of fire in the coast artillery depends almost wholly on accurate range and position finding, and this work is seldom accomplished in the immediate vicinity of the guns. Mortar batteries are absolutely useless without the adjunct of position finders. Unless other provisions be made the observers for these instruments must be taken from the batteries themselves and the personnel at the guns will thus be weakened by the detail away of its best instructed men. Moreover, it is impossible on account of other duties to give soldiers in batteries the constant training which will make them skilled and accurate observers with the position finding instruments now adopted. These specialists should have the qualifications required by a surveyor in civil engineering and belong, as do electrician sergeants, to the post non-commissioned staff.

It is very important that there should be disseminated a more just appreciation of the value of position finding, fire control and direction in the coast artillery.

It has been generally accepted by the public, and even believed by many who have made more than a casual study of military affairs, that men who have been taught the drill manual of the gun, who have learned to load, to adjust the sight or quadrant and to fire, thereby become proficient artillery men.

There could not be a more erroneous idea.

The whole theory of fire control and direction to secure effective fire in the coast artillery, depends upon position finding. In mortar batteries, since the target cannot be seen from the mortar pit, "the man behind the gun" is *nil* without position finding, however well instructed he may be.

In other batteries, from which the target can be seen, if "control and direction" fail, fire cannot be concentrated from all the guns on a single target or at will distributed; if "position finding" fail, the effect of fire is diminished from 50 to 75 per cent. In the destruction of the Spanish fleet off Santiago, Cuba, "the man behind the gun" in our war vessels has a record of only 3 per cent. of hits.

In a night engagement, without the aid of electric search lights and position finding, no particular effect may be expected from the fire, however well instructed the personnel at the guns may be. The tremendous advantage which coast artillery has over naval attack, and which is of recent date, depends almost solely upon the superior position finding of the land defense.

With a Chinese veneration for tradition, our artillery is still organized into regiments of a fixed number of batteries of a definite strength, long after any occasion for such organization has existed. In the infantry and cavalry the regiment is an adsolutely indispensable unit both for fighting and administration, two or more of which units form a brigade.

In the coast artillery not only is there no need for a regimental unit, but it is absolutely an encumbrance. An artillery regiment never has been and never will be fought as an *artillery* unit. In no proper sense is it even an administrative unit. Under our regulations and customs of the service, the regimental commander has no control over the instruction, drill, discipline or administration of batteries beyond his post. His impress disappears at the limits of his command.

To illustrate, let us take the 3d Artillery with headquarters in San Francisco harbor and with batteries scattered along the Pacific Coast, in Kansas and in the Philippines. This regiment, it is apparent, is a unit only in title, to the component parts there is absolutely wanting the harmony in discipline instruction and administration which is essential to the formation of a true military unit. Imagine the absurdity of a regimental unit in which the mounted batteries march with the infantry and cavalry and the coast batteries are rooted to the ground with their guns.

There is no more reason why coast batteries should have a fixed number of sergeants, corporals and men, than should all war vessels have the same number of men in its crew. The navy is very much in advance of the artillery in this respect. The crew of a battle ship, of a cruiser, or of a gun boat, is adequate to its needs. A fort has a fixed number of guns, an electrical plant and a system of fire control and direction. By the drill regulations, a certain number of men are required to operate them ; the garrison then should be sufficient to man the fort with an allowance for guard, reserves and the sick. It needs no more and should have no less.

To illustrate how ill adapted is our present organization to meet artillery needs, we will take four forts, and state the number of men required to furnish one relief, based upon the drill regulations for the coast artillery, to fight the armament at:

	One relief.
Fort Strong, Boston Harbor, Mass.,	131 men.
Fort Mott, Delaware River, N. J.,	150 men.
Fort Armistead, Baltimore Harbor, Md.,	94 men.
Fort Hunt, Sheridan Point, Va.,	57 men.

Assuming the strength of a heavy battery as now fixed by the President at 120 men, we observe there is no way of giving a full complement of men to the forts named, if the assignment be by batteries, unless we accept in all cases an excess beyond the needs of the armament.

The scheme I have presented may seem novel, but it is no untried theory; it has been the practice for years in the British Army, as the following quotation from "The Army Handbook of the British Empire" (official publication), edition 1893, page 219, shows:

"The establishment of men and horses in the batteries of horse, field, and mountain artillery are fixed according to the nature and locality of the service. but the companies, formerly batteries, of garrison artillery are regulated according to the nature of the works and armaments which they have to serve.

"Formerly when more men were wanted at a station, more companies or batteries were added whether more officers were wanted or not. The result was a waste in one or the other direction. At the same time, it was apparent that the staff that managed one of the small companies could administer a larger one (say up to 200 men). Therefore, the principle was introduced of adapting the size of the company to the actual requirements of the station where it was to serve."

It may be mentioned that there are five officers in an English battery, one major, one captain, and three lieutenants.

The artillery, to reach its best measure of efficiency, must be organized into a corps to include both coast and field artillery, and this corps must have a chief. The change from a regimental to a corps organization will not in any way increase expenses; but there will be the great advantage that each senior officer will have a compact and flexible command for the drill, discipline, instruction and administration of which he can clearly be held responsible.

The approved drill regulations for our coast artillery define clearly the chain of command which should be carried into effect by legislation, Fortress Commander, District Commander, Fire Commander, Battery Commander. To each responsibility there is an appropriate rank.

Let us again illustrate by Portland Harbor. The Fortress Commander, a Colonel, will command all the land defences and the submarine mines operated from land. Two District Commanders, Lieutenant Colonels, one will command the troops defending the approach by Portland Head; the other will command the forts defending the approaches from the east. Seven Majors as Fire Commanders or in command of mortar batteries; thirteen Captains, thirteen 1st Lieutenants, and thirteen 2d Lieutenants of batteries, and one thousand one hundred and twenty-four enlisted men. This force represents a regiment, yet the Colonel will be in close touch with all the units under him, and can be fairly held responsible for the drill, discipline, instruction and administration of his command.

The strength of the coast artillery should be fixed to-day at the number of officers and men required to fully man the forts with their armaments now mounted or provided for. This strength is absolutely independent of any tactical relation to the infantry or cavalry. It would remain the same if there were no infantry or cavalry, or if we had an army of 100,000, or of 200,000 men. The field artillery will accompany Divisions, Corps and Armies in the field. It has, therefore, a tactical relation to the other arms of the line and its strength should depend upon the total strength of the line of the Army.

There are officers, both in and out of the Artillery, who have expressed the fear that the organization of Artillery into a Corps with a Chief of Artillery would create another bureau in the War Department. The Chiefs of the War Department bureaux are all staff officers. Artillery is intended to fight and cannot be divorced from the line of the Army. The Chief of the Artillery will be a line officer and naturally on the staff of the Commanding General of the Army as Inspectors of Artillery are now on the staff of the Department Commanders. Any thought of legislation to remove the chief of artillery or his corps from the military hierarchy cannot be too strongly discredited in advance.

In conclusion, I wish to recommend that the artillery be organized into a corps, with a chief of artillery, who shall be a Brigadier General; that the regimental organization be abolished; that in the coast artillery, the Fortress Commanders be Colonels, the District Commanders be Lieutenant Colonels, the Commanders of Fire Commands and Mortar Batteries be Majors; that batteries have each one Captain, one 1st Lieutenant, and one 2d Lieutenant, and sufficient non-commissioned officers and privates to be adequate to the armament it is to serve; that the Light Artillery shall have one Colonel, one Lieutenant Colonel, and three Majors for each twelve batteries, each battery to contain one Captain, two 1st Lieutenants, and one 2d Lieutenant, and the present organization of enlisted men, and that there shall be provided for administration a sufficient commissioned and non-commissioned staff; and that the artillery post non-commissioned staff of specialists shall consist of electrician sergeants and of observer sergeants.

Very respectfully,
Your obedient servant,
J. P. STORY,
Major 7th Artillery,
Artillery Inspector.

AUTOMATIC SIGHTING.

By Colonel H. S. S. WATKIN, C. B., R. A.

Chief Inspector of Position Finding.

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The question of Automatic Sighting is now so much to the fore, and so many statements have been made as to their capabilities, that I think it might be of interest to look into the question both from a theoretical and practical point of view.

An automatic sight is one which finds the range and at the same time sets the gun to the elevation due to that range, by the mere act of laying the sights on the water line of the object. It is a ***sine quâ non:***

(1). That the gun must be at a certain known height above the water level; the greater the height the greater the accuracy.

(2). That the platform or emplacement must be truly level all round, and must continue so during firing, and this to a far greater accuracy than we have hitherto been accustomed to in our coast guns.

The theory of the apparatus will be seen from the following:—Let *F B* represent a gun, placed at a height *B D* above the sea-level *D C*, and at such an angle of elevation that a shot fired from it will hit the water at the point *C*. Draw *E B* paraellel to *D C*. It is clear that under these conditions, if the tangent scale *A F* is raised to a height *A F*, representing the elevation due to the range *B C*, the object *C* will be in line with the fore and hind sight.

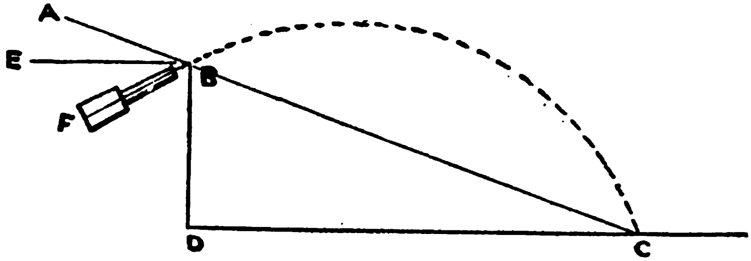


Fig. 1.

Then $ABF =$ *Tangent* angle of elevation.
$EBF =$ Quadrant angle of elevation.
$BCD =$ Angle of depression of object due to the height of the battery and the range, conveniently called the range-finding angle.

$$EBF = ABF - ABE.$$

But $ABE = BCD$ because EB was drawn parallel to DC.

$$\therefore EBF = ABF - BCD.$$

The angle BCD for ordinary heights can always be calculated from the formula:

$$\text{Depression angle in minutes} = \frac{\text{Height in feet} \times 1146}{\text{Range in yards}}.$$

The condition to be fulfilled then for automatic sighting, is that when the gun FB is elevated to any given angle to the horizon (quadrant angle), the tangent scale FA must at the same time be automatically raised to the height, representing the distance the shot will be thrown due to that quadrant angle, or *vice versâ* if mechanism to fulfill the above condition is fitted to a gun, then whenever the eye looking over the sights sees the water line of the object, the gun will of necessity be at the right quadrant angle to hit that object.

It may not be generally known that having a gun fitted with a quadrant elevation scale, a modified form of automatic firing may be carried out. Thus, suppose we wish to fire at a target at a distance of 2200 yards which is slowly coming in. We could place the gun at the quadrant elevation due to 2,100 yards, raise the tangent scale also to 2,100 yards, and fire the moment the sights are on the water line of the target. It is evident that by so doing we have fulfilled the conditions given in figure 1, and that when the object is seen over the sights the target is at 2,100 yards.

The conditions of accuracy can be obtaind from the equation.

$$EBF = ABF - BCD,$$ and are

(*a*). That the range-finding angle BCD must be obtained with accuracy, in order to obtain the range for setting the tangent scale ABF.

(*b*). That any variation in the level of the platform will seriously affect the accuracy, in as much as it alters the quadrant angle EBF, and the angle of inclination of the sights.

With regard to (*a*) it is clear that the greater the height the less any inaccuracy in obtaining the depression angle will affect the range, and a short range will be far more accurately obtained than a long one. Take for example a height of 50 feet and 200 feet and ranges of 1,000 yards and 5,000 yards.

At 50 feet the depression angle for 1,000 yards is 57·3. minutes.
" " " 1,025 " 55·9. "
" " " 5,000 " 11·46. "
" " " 5,025 " 11·40. "

That is to say to observe to an accuracy of 25 yards an angle of 1.4 minutes must be taken at 1,000 yards, but at 5,000 yards an angle of observation of 0.16 minutes is required.

At 200 feet the depression angle for 1,000 yards is 3° 49 minutes.
" " " 1,025 " 3° 43 "
" " " 5,000 " 0°.45.84 "
" " " 5,025 " 0°.45.61 "

That is a difference of 6 minutes, only alters the range 25 yards at 1,000 yards, but at 5,000 yards an error of 0·23 minutes, will cause a same alteration of range.

These examples show what small angles have to be observed when the height of the battery is small, and that far more accuracy is required at long ranges than short ones. A good rough rule for obtaining the errors at various ranges, is to multiply the error at 1,000 yards by the square of the range. Thus, supposing the error *due to laying* be 20 yards at 1,000 yards, the error from the same causes at 2,000 yards would be 20 × 4 = 80 yards, at 3,000 yards it would be 20 × 9 = 180 yards and so on. The error due to height for any *given* range is very nearly inversely proportional to the height. Thus, for example, if an error of 20 yards is obtained at 150 feet height, the error from the same cause would be three times twenty at a height of 50 feet.

The errors we have been discussing are those due to actual laying, the important question then is with what accuracy can the human eye observe an angle. I have had considerable experience in this matter, and I feel convinced that the limit for *deliberate* laying is one minute, and a greater angle if the eyesight is not good, or properly trained. But where as in automatic sighting the observer has to follow a rapidly moving object, this limit must be at least doubled.

Granting this, it is easy to lay down the error that will be obtained with an automatic sight, from this cause, at any given range and height. The following is a table assuming the error to be two minutes :—

Height. Feet.	Range. Yards.				
	1000	2000	3000	4000	5000
50	36	149	351	651	1058
100	18	72	166	305	478
150	12	47	109	196	308

The above are the errors worked out mathematically. For those who may be sceptical on these points, the following gives the actual errors of laying an automatic sight in 1879 when tried by a committee of experts. The sights were laid on a steamer moving out of the harbor, height of battery 150 feet.

Range.	Error.	Range.	Error.
1310	40	2580	210
2240	90	3140	500
		3900	890

So far then as regards the error due to the unaided eye, of course this will be reduced if telescopic power is applied. In certain weathers, in fog, and with powder smoke hanging about, a telescope cannot always be used with advantage.

We now come to the serious errors arising from want of level of the emplacement platforms, etc. It must be in the experience of all officers who have worked with Coast Artillery how much the racers are out of the truth, and if level to-day soon go out of truth with firing. So that the application of automatic sighting to the older form of guns and platforms is out of the question except for very short ranges. Even with the newer types the accuracy must be very considerable. Suppose, for purposes of calculation, we take the error of platform at four minutes, the following table gives the error for a 6″ Q. F. gun mounted at a height of 50 feet.

Range.		Error.
1000 yards	+	12 yards.
2000 "	or	270 "
3000 "	—	750 "
4000 "		1550 "

(+ when platform is depressed).
(— " " " elevated).

The method of arriving at these figures is as follows. Imagine the gun fitted with automatic sights to be placed on a platform capable of being titled. When the platform was level, and the sights laid say at 2000 yards, the gun would be at a quadrant elevation of 1° 28′, that is 1° 57′ (tangent elevation for 2000 yards) minus 0° — 28·6′ (the range-finding angle).

Now if the platform is tilted 4′ down to the front it is evident that the gun will be at 4′ minutes less quadrant of elevation, and thus throw the shot 57 yards short of the 2000 yards. At the same time the line of sight will also have been tilted 4′ down, and will cut the water at 1757 yards instead of 2000 yards. So that when the gun-layer brings his sights up to the target at 2000 yards, he will be virtually elevating the gun to 2270 yards (see above table). We see then that a very slight variation in the level of the platform, causes a larger error in the quadrant elevation, owing to the automatic mechanism.

I think I have given figures enough to show that, except under special conditions, automatic sighting will not and cannot do away with the ordinary way of finding the range and laying the gun. Officers who have worked with the D. R. F. and P. F. know how exactly the instrument must be levelled in order to obtain correct ranges, and this with levels that easily show difference of a minute. How then is it possible to make a big gun on its comparatively rough mounting into a range-finding instrument. Of course, if you can get a site with a height of 200 or more feet, and are satisfied with moderate ranges, it can be done, but extraordinary care must be taken even then to have the racers, etc., very true.

It must be remembered that in firing with an automatic sight, the errors given under the headings (*a*) and (*b*) might be in the opposite direction and counteract one another, and good shooting would result; on the other hand they might be in the same direction when the results would be deplorable.

So far I have only given the theoretical conditions on which the automatic sight is based, the methods of carrying them into practice have been various. The one that perhaps will be most easily understood is the Italian sight tried in 1878–79. In this a rack *G* fixed to the carriage, revolves a pinion *H* in a fitting attached to the gun. Fixed to the pinion are three cams *E*, for use at low, mean and high tide. The tangent scale *A* sliding up and down freely in a socket *B* fixed to the gun has its lower end resting on one of these cams. The cams being cut a proper curve it follows that when the gun is elevated or depressed the pinion *H* is revolved by the rack *G*, and the sight raised or lowered to the proper height to fulfill the conditions given in figure 1. This arrangement is rather inconvenient for the "layer," as he has to raise and lower his head for every movement of the gun.

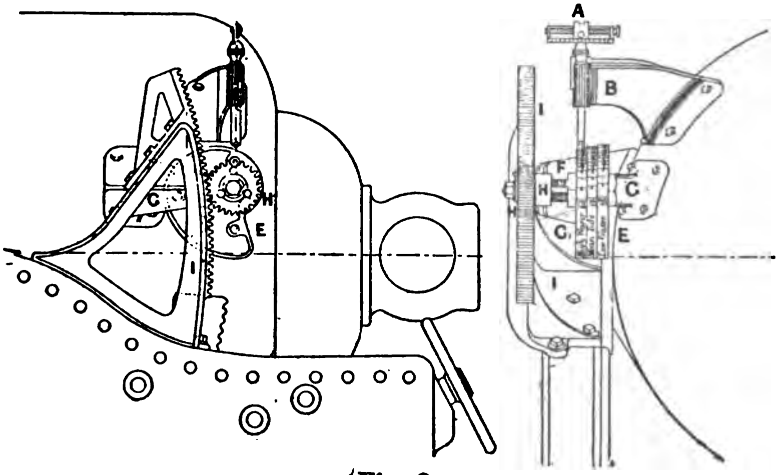


Fig. 2.

I had tried some experiments at Gibraltar in 1876 on the same

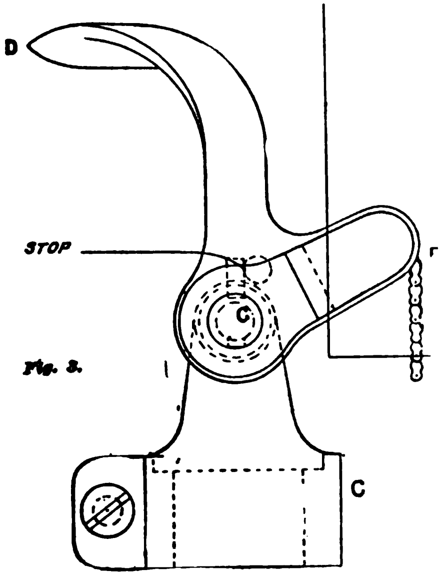


Fig. 3.

lines but found the racers too much out of truth to admit of any accuracy. In designing my sight in 1894 for the War Office, it occurred to me that the disadvantage of the hind sight moving up and down would be got over if it could be arranged for the fore sight to move instead. It is evident that as far as giving an angle of elevation is concerned it matters not which sight is moved. Figures 3 and 4 show this sight which was successfully tried at a target travelling 18 to 20 knots. It is fixed to the ordinary fore sight of the gun, with which it did not in any way interefere, and thus allowed of ordinary laying being restored to at any moment. A 6-pr. in which the sights recoiled with the guns was purposely selected by the committee, and I was specially debarred from using a telescope. Figure 4 gives a front view of the fore sight of the gun with my automatic arrangement fitted to it. Figure 3 a side view, both full size.

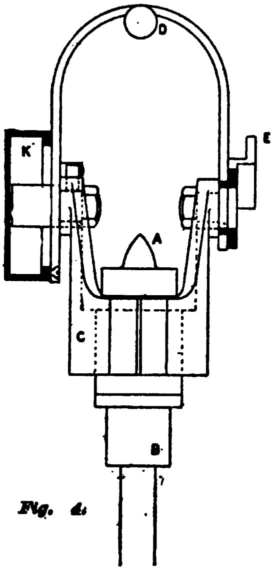


Fig. 4.

D is an acorn sight at the end of a lever *GD*, which is capable of revolving round an axis *G*. *G E* is a projecting piece, forming part of the lever *G D*. Around the end of *E* is passed a chain, one end of which is fixed at *H*; the other end being attached to a fixed part of the mountings. A spiral spring *K* enclosed in a box presses the lever *G E* upwards, and thus keeps the chain taut. It is evident from this arrangement that as the trunnions on which the gun revolves are behind the fore sight, if the gun is elevated the chain pulls down the lever *G E*, and with it the point of the sight *D*. This as far as sighting is concerned is the same as if the tangent scale was raised. The amount the point *D* is depressed for any given movement of the gun is governed by the position, length and shape of the end of the arm *G E*. This is arranged to suit the height of the gun above the sea-level, so that the condition given in Figure 1 may be fulfilled. That is the act of laying the sight on any object on the sea-level, brings the gun to the right quadrant elevation to hit that object. To allow for rise and fall of tide, or variation of powder, the end of the chain attached to the fixed portion of the mounting is capable of being moved up and down by a milled headed wheel, on which was engraved yards over or under, and feet scale, of rise and fall of tide. The officer in charge could thus *without stopping or interfering with the layer* alter the shooting as he pleased to meet the variation of the day.

The problem of automatic sighting, applied to the carriage with no recoil to take into account, is, I think, a simpler matter, and more easily admits of the application of telescopic power. As to the best telescope, I have no hesitation in saying it should be one with very low magnifying power and large field. After a good deal of difficulty I managed to obtain such a telescope.

In conclusion, I trust I have sufficiently explained automatic sighting to allow of the principle on which it is based being understood and at the same time pointed out the danger of supposing that it can take the place generally of the present methods of laying guns.

PROFESSIONAL NOTES.

ORGANIZATION AND ADMINISTRATION.

Transport Service of the United States Army.

It can truly be said that the transport service of the United States government is the wonder of the world, and no end of credit is due to the quartermaster general's department for the speedy organization of the service. It must be remembered that it is the first time in its history that the United States has operated a line of transports, and the manner in which the officials have surmounted every difficulty is truly marvelous. The remarkable success which has attended the trips of the remodeled transports Grant, Sherman and Sheridan from New York with reinforcements for General Otis at Manila has caused universal comment and has showered upon the war department no end of praise from other nations.

The great success achieved by the quartermaster's department in the construction of the troopships Grant, Sherman and Sheridan has induced the war department to increase the number of such ships. Three of the largest army transports which were used on the West Indian station during and after the Spanish war have been selected for this purpose and are now being remodeled into troopships. These are the Logan, Meade and Thomas. The two first named are now in process of refitting and renovating in Brooklyn, and the Thomas is being remodeled at the Cramp ship yard, Philadelphia. Notwithstanding the extensive character of the alterations being made to the ships, it is expected that they will be completed and ready for the transportation of troops to the Philippines by November 1 at the latest. The three vessels have an aggregate capacity of 5,000 men. It is contemplated that each vessel will carry one entire regiment and one battalion of another regiment with ample room for wives and families of the officers and non-commissioned officers.

In fitting up the transports the officials of the quartermaster's department worked out the problem for themselves. Advantage was taken, of course, of the experience of other nations in transporting troops, but the accommodations provided for the comfort and health of the soldiers represent new ideas, and the American innovations have all been found improvements.

When war with Spain proved inevitable and preparations for hostilities were undertaken, nearly all the divisions of the war department were caught unprepared. But the tasks involved in recruiting and equipping an army were no more serious than those which confronted the quartermaster general, who was charged with the added responsibility of providing transportation for the troops that would be sent abroad for service. The new duties were mastered with a success that warranted more attention and commendation than has been bestowed. With the navy having a blanket over all the desirable vessels of American register and Congress declining emphatically to relieve the emergency by granting register to foreign vessels, the quartermaster general succeeded before the end of June, 1898, in chartering forty-three transports on the Atlantic and fourteen on the Pacific, with water boats, steam lighters, ocean tugs and deck barges, but the experiences in moving troops to Santiago demonstrated that the facilities were not sufficient and fourteen large steamers were purchased and added to the transport fleet. These vessels conveyed during actual hostilities 28,195 men to Cuba, 17,460 to Porto Rico, 16,405 to Manila and 629 to Honolulu, and returned from Cuba 21,686 men and from Porto Rico 5,540, in addition to the 2,920 civilian employes transported. Since the close of hositilities with Spain there have been transported to and from Cuba about 42,000 men; to and from Porto Rico about 15,000 men; and from the Philippines about 5,600 men, making a total movement of 155,436 men. This, however, was only a temporary service. The vessels had been prepared for the accommodation of troops during the emergency, but the fruits of the war entailed new duties upon the quartermaster general's department. The acquisition of Porto Rico and the Philippines and the temporary occupation of Cuba necessitated the establishment of a permanent system of ocean transportation, and when Aguinaldo and his followers opened fire upon the American troops, starting a rebellion which required the forwarding of reinforcements to General Otis, the work that had been done in the way of providing a fleet of transports was given a trial.

WHAT THE FLEET CONSISTS OF.

The transport fleet of the United States now consists of eighteen vessels, all purchased from steamship companies with the exception of two, the Panama and the Rita, which were captured by the navy and bid in by the department when sold as prizes of war. All these vessels have been remodeled and refitted or are now in course of transportation. In addition to the transport fleet chartered for the Cuban and Porto Rican campaign, a fleet of chartered steamships was fitted out in the early summer of last year for the transportation of troops from San Francisco to Manila. For this movement there were chartered seventeen large and commondious ocean steamships. As this involved a voyage of over 7,000 miles—a portion of it through a tropical clime—it was necessary that the ships in which the troops were to make this long voyage be specially fitted with a view to the health and comfort of the men. There have been carried from the United States to Manila about 17,000 men and the reports show that this army was delivered at Manila without a single mishap and the men in condition for active operations as soon as they had disembarked. Since then nearly all of the orginal army of volunteers has been returned to the United States. There is now an army of 31,000 in the Philippines and an additional army of 30,000 is *en route*. This shows in a measure the immense labor of the transport department. Nearly 100,000 men have been or will be transported.

Twenty-three of these chartered transports, not including the animal ships, are still in the Philippine service, and in addition two large steamers, the Hancock and the Warren, have been elaborately fitted up.

The three transports, Grant, Sherman and Sheridan, are at present the pride of the quartermaster's department, though as stated the department expects to surpass them in the Logan, Meade and Thomas. The Grant, Sherman and Sheridan have a gross tonnage of 5,558, 5,780 and 5,673 tons respectively and have been completely overhauled and remodeled. The Sheridan, before refitting, carried eighty officers, 1,000 men and 1,000 animals and on one trip from Newport News to Porto Rico even exceeded this record by carrying forty-three officers, 1,130 men and 1,005 horses and mules. These vessels have bilge keels, which steady them considerably while at sea and materially increase their value as transports. On their trips from New York to Manila, the Grant carried a total of 1,758 persons and the Sherman a total of 1,799. The Sherman on short trips from Savannah to Havana has carried ninety officers, 2,082 men and twenty-five animals, besides forage, subsistence and quartermaster's supplies for sixty days.

HOW THE PRINCIPAL SHIPS ARE EQUIPPED.

These ships embody many new features and are unqualified successes. The hulls and decks of the ships were not changed but were thoroughly renovated and repaired. Each has four decks besides the hold and the bridge—spar, main, 'tween and orlop decks. On the bridge deck, in addition to the pilot house and captain's cabin, the quartermaster has his office and there is a pantry, a locker and twenty-four state-rooms for officers. The forward part of the spar deck is open and offers a promenade and place of exercise for the officers and men. The center of the deck from amidship toward the stern is given over to a large saloon, where the officers' meals are served; adjoining is a pantry, and separated by an aisle is a store room and linen closet. Back of the funnel there is a galley and another linen closet, the officers' social room and staterooms for the chief engineer and his six assistants. On one side of the ship, separated from the saloon by an aisle, are toilet and bath rooms, a pantry, the bakery and thirteen staterooms. On, the opposite side of the saloon, also separated from it by an aisle, are fifteen staterooms and a storeroom. There are four hatches on the forward part of this deck and two in the space between the superstructure described and the wheel house and lavatory, which occupy the stern.

The main deck has in the bow, quarters for the firemen, coal passers, seamen, oilers and watertenders. The lamps and paints are kept on this deck forward of the carpenter shop. The donkey man and mate, the boat man and mate, the carpenter and mate, quartermaster, baker, steward, pantryman, scullions, stewards and mess boys have quarters here, adjoining baths and toilets. There is considerable clear space between these quarters and the coal hatches, which are in front of the firemen's and seamen's wash places. Back of the space reserved for the boilers and engines is refrigerating machinery and engineer's stores. These occupy the center of the deck amidship. On one side, opposite the engines and boiler spaces, are mess rooms respectively for the seamen, firemen, coal passers, the petty officers, oilers and water tenders. On the other side is the steam galley and scullery. Back of the oilers and water tenders' mess is the electric generator, stores and refrigerator. Back of the refrigerating machinery is a 600-gallon fresh water tank and engineers' stores. Adjoining the scullery the cabin stewards have their mess.

The hospital is on this deck in the stern but separated from these compartments. It is equipped with all modern appliances. It has sixty.four separate hospital bunks and is surrounded by the dispensary and stores, the surgeons' rooms and staterooms for the hospital stewards. The perfection of the hospital has been especially commented on by the medical officers abroad who have had an opportunity to inspect it. The clear spaces fore and aft on this deck are provided with swinging tables and stools for messing the enlisted men. These tables are so arranged that when not in use they are swung out of the way, leaving a clear space for the exercise of the men. Also upon this deck there is an organ with books and hymns and songs for use in religious and other service.

The next deck, known to the initiated as 'tween decks, is given over to the troops, and here the ingenuity of the quartermaster's department has been demonstrated to its greatest degree. In the foreign service it is the general practice to give soldiers on transports the sailor's bunk—that is the hammock—but our new transports have been fitted up with a regular bunk. It is a structure made fast to the deck, three tiers high and composed of gas pipe. The soldiers sleep on canvass, each man having his individual strip, which is tied to the framework of the bunks and can be readily removed for airing or washing. The bunks are also removable and may be taken down whenever it is desired to have the unobstructed space for the exercise or amusement of the men. Aisles are liberally distributed between the tiers of bunks, which are in no case more than two men deep, These sleeping accommodations are arranged to economize space to the greatest degree possible in placing the men in hammocks three layers deep.

On these decks accommodations are provided for 1,212 soldiers. They are not all in one room. Bulkheads have been thrown across the ship, dividing it into communicating compartments, which may be made watertight, should occasion require. In the extreme bow, rooms have been provided for the seamen and firemen where they may retreat when off duty for amusement.

The next, or orlop, deck has berth accommodations for 924 men. The boilers and engines again occupy the space amidship and a quantity of coal is stored on this deck in front of and alongside the boilers and engines. Forward there are three large rooms fitted up for the troops. Aft of the engines is a large coldroom and icehouse and stores. The fourth trooproom on this deck is at the stern with 198 berths. The magazine is in the extreme stern.

SUPPLIES AND EQUIPMENTS IN THE HOLD.

Below deck in the hold are the supplies and equipments. For this purpose the hold is divided into six compartments, the forward four being occupied principally by officers' and company equipments, ambulance wagons and ammunition. There is a place for everything, and the supplies carried in the compartments are stored so as to be readily obtainable. In one the barrels of beef are first placed and a flooring laid over them upon which the barrels of pork are placed and on top of all barrels of hard bread. Adjoining the filed ranges are first stored and barrels of hard bread placed on top. These are about the only ration supplies carried forward. The quartermaster's supplies of clothing, hats, shoes, etc., have a place; also the household headquarters and gymnasium furniture. The arrangement of the two aft compartments is practically perfect. Electric lighted aisles penetrate them and everything from a cake of soap to a barrel of flour has its particular place.

Some experts contended that it would be impossible to transform the steamers constructed for carrying freight into troopships. In this respect the greatest obstacle to overcome was the ventilating. It was urged by some that soldiers put on the orlop and 'tween decks could not survive a trip half way across the globe. A system of ventilation was installed that has proved entirely successful. Four large steam fans were placed on the spar deck and connected, (fitted with air coolers, cleaners and heaters, distributing pipes, ducts and registers), to all spaces occupied by the troops—hospital, toilet rooms, pantries, forecastle and in fact all rooms except those on the bridge deck. The registers in the ventilating pipes are operated at the will of those occupying the room, and by forcing the air over coils of steam pipes it is heated when desired. This is necessary aboard a ship traversing various zones. Fifty additional side ports with shutters were placen in the refitted transports and a complete electric system of abount 550 lamps was introduced. About one hundred enameled wash basins of the latest patterns, both tubs and shower baths in abundance were scattered about the ship and salt water supplied to them. The transports in making the run from New York to Manila had to coal four times, but by experience the officers will soon learn various ways in which the fuel may be economized. The Hancock and Warren, now on the Pacific, will be joined by the Grant, Sherman and Sheridan, and regular and frequent communication established between Manila and San Francisco. The transports will take coal at both ends of the run and also at Honolulu, where the coal pile of the navy will be used and paid for by the war department.

The remarkable success attained in the speedy organization of the transport, if due to any one man, is due to the intelligent direction and untiring work of Colonel Charles Bird, who has been for some years in charge of the transportation department of the quartermaster general's office. The brunt of it fell upon his shoulders and he has borne it well. Credit is also due to Colonel F. B. Jones, the general superintendent, and his officers in New York, and to Colonel O. F. Long in San Francisco for the manner in which they have carried out the instructions of the quartermaster general's office.

The transport fleet of the United States government to-day is as follows :

VESSELS OWNED BY THE GOVERNMENT.

Old Name.	New Name.	Capacity, Men.
Arizona	Hancock	1,200
Berlin	Meade	1,200
Chester	Sedgwick	1,200
Clearwater	Ingalls	150
Manitoba	Logan	1,800
Massachusetts	Sheridan	1,800
Michigan	Kilpatrick	800
Minnewaska	Thomas	1,800
Mississippi	Buford	650
Mobile	Sherman	1,800
Mohawk	Grant	1,800
Obdam	McPherson	850
Panama	Hooker	
Port Victor	McClellan	800
Rita	Burnside	250
Roumanian	Crook	1,000
Scandia	Warren	1,224
Bay State	Wright	200

HOSPITAL SHIPS.

Relief, Missouri, Terry.

TUGS.

Ord, Weitzel, Reno, Richardson, Sumner, Reynolds, Poe.

STEAM LIGHTERS.

Slocum, Kearney, Williams, Baker, Canby.

PACIFIC—SHIPS FOR CARRYING ANIMALS.

Name.	Capacity, Animals.	Name	Capacity, Animals.
Tacoma (sailing ship)	206	Aztec	400
Conemaugh	295	Garrone	411
Lellanaw	286	Port Albert	519
Wyfield	140	Victoria	417
Centennial	286	Siam	325
Athenian	411	Lennox	400

CHARTERED VESSELS ON THE PACIFIC—TROOPSHIPS.

Name.	Capacity, Men.	Name.	Capacity, Men.
City of Sidney	850	St. Paul	850
Zealanda	600	Charles Nelson	550
Senator	713	Tartar	1,200
Morgan City	600	Belgian King	800
City of Para	1,000	Tacoma	550
Indiana	900	Glenogle	800
Ohio	724	Columbia	600
Valencia	500	Elder	600
Newport	500	Victoria	800
City of Pueblo	820	Olympia	700
Pennsylvania	1,200	City of Rio Janerio	775

—*Marine Review*, September 28, 1899.

MILITARY HISTORY.

Events in Cuba Subsequent to the Ten Years' War (1878-1895).

BY ANTONIO GONZALO PEREZ, DOCTOR OF LAWS, HAVANA UNIVERSITY.

The month following the termination of the Ten Years' War all was rejoicing and congratulation in Cuba. Peace is never so fully appreciated as immediately after a prolonged and exhausting struggle, in which both the combatants have been tried to the utmost. Marshal Martinez Campos, the Pacificator, as he was called, was appointed Captain-General in order that he might inaugurate the era of reform which had been pledged to the Cubans at the Treaty of Zanjou. New laws and decrees were enacted and promulgated by the thousand, for Spain is the most prolific of law-making nations. A new political, financial, military, and ecclesiastical division was made of the island. Fresh departments and offices were created in all branches of the Administration. Provincial and municipal councils were also formed, not so much, however, with a view to satisfy the natural aspirations and necessities of the Cubans, as to make room for thousands of "bureaucrates," civil and military *employés* appointed by Spain, and chosen amongst people residing in the Peninsula. Even in the establishment of judicial courts the interests of Cnba were overlooked, in order to strengthen the official influence of the Spaniards residing in certain localities, and thus to retain, under the disguise of liberal reforms, all monopolies, oppressions, and sytematic peculations of the old *régime*.

The representation of Cuba by senators and deputies in the national Parliament was one of the principal reforms agreed upon by Cubans and Spaniards in the Treaty of Zanjou. The appointment of such representatives was to be made by the free election of the people—that is to say, by those having the right to vote. To enjoy the franchise it was necessary to be twenty-five years of age, and to pay at least ten dollars per annum to the Administration in direct taxes. The number of senators and representatives was fixed at fifteen of the former, and thirty of the latter, or according to the population. Two great political parties were formed—to wit, the Conservatives, composed of Spaniards, and the Liberal Autonomists, to which party belonged the immense majority of the Cubans. The political field thus divided, the platform of both parties was essentially different. The doctrine of the Conservative, or pro-Spanish party, was principally the maintenance *à outrance* of the *status quo*, with all its privileges, monopolies, and injustices, the resistance to all kinds of reforms in the Administration, and the exclusion of the Cubans from official positions—in a word, the control, as heretofore, of Cuba by the Spaniards, and for the benefit of the Spaniards by right of conquest. The platform of the Autonomist party, on the other hand, upheld the right of self-government, the extinction of all monopolies, the cessation of all injustices in the Administration, the financial and political right of the Cubans to cut down expenses and lighten taxation.

The difference between the two parties was necessarily irreducible, as also were their aspirations and principles. Taking into consideration the fact that the Cuban voters ten times outnumbered the Spanish, the triumph of the Autonomist party would have been certain had justice presided over the elections. Besides which, the influence of the cultured and wealthy was all on the side of the Cubans. But the defeat of the Conservatives would have meant the defeat of Spanish rule in Cuba, the colonial power of Spain having had no other foundation anywhere, or at any time, than oppression and tyranny. Therefore the Government could not contemplate with indifference the unequal struggle between the two elements of the population of the island; and for this reason from the beginning eagerly cast all its power and influence on the side of the Conservatives, which power, like the sword of Brennus in the story of ancient Rome, heavily inclined the scale in favor of the Spaniards. Every kind of persecution was employed against the Autonomists, and all sorts of frauds were committed by the officials of the Administration in the registration of the votes, whilst, at the polls, the brutal force of the army was more than once employed in order to deprive the Cubans of the fruits of victory, the consequence being the triumph of the Spaniards at every election. And so decisive were such victories that Cubans generally could elect but three or four deputies out of thirty, and one or two senators out of fifteen. In some elections in the district of Havana, where the power of the Spaniards was greatest, the Autonomists were not allowed to elect any representative whatever.

It is unnecessary to state, in order to be understood, that Spain never fulfilled any of her promises to the Cubans. On the contrary, the Treaty of Peace sank gradually into oblivion, and the further the date of its signature receded into the past the less heed did the Government pay to its pledges.

The spirit of mistrust and suspicion, however, always latent in the Spanish breast, grew daily more intense. The Conservative party, openly and effectively aided by the authorities, began to carry out a plan whereby they might exclude the Cubans from official positions; and presently even the very lowest of these positions fell into the hands of Spaniards.

In pursuance of this end, preference was accorded by law to retired soldiers and sailors rather than to civilians, the army and navy being exclusively composed of Spaniards. The natives had always been, and were still, exempt from military service, and this exemption was but another proof of Spanish mistrust. Notwithstanding the tremendous havoc wrought by the late war in the public treasury, direct taxes to meet the extravagant expenses of the Central Administration, amounting to forty millions of dollars (40,000,000), were imposed upon the unfortunate taxpayers, who, unable to meet them, were compelled in many cases to turn over their properties to the Government. In vain was any kind of protest; the Administration only responded by rendering still more vexatious the proceedings connected with the collection of the said taxes.

Irritating monopolies of every description were accorded to Spanish productions, which were not dutiable, or only insignificantly so, in the Cuban Custom Houses. On the other hand, Cuban productions were overtaxed in Spanish ports, and, what is worse, their free sale was prohibited in Spain. Moreover, a high tariff was put upon foreign goods in Cuba, not so much for the purpose of collecting a large revenue as to render impossible any competition with goods exported from the Peninsula. In this way was Cuba forced to consume inferior Spanish goods. The financial tyranny of Spain equalled her political tyranny; neither can be matched anywhere save in the history of that decadent nation.

Living, or rather dying, under such a despotic rule—for life was deprived of all that makes it worth living—there is nothing astonishing in the determination of the Cubans to appeal once more to force of arms as the last and only remedy for their woes. Accordingly, in the year 1879, another revolution broke out in the eastern part of the province of Santiago, which is known as "The Little War." It lasted less than a year, for, owing to lack of resources, the leaders saw that there was not the slightest chance of success. They therefore reluctantly abandoned their fruitless attempt at emancipation, yielding, however, this time rather to the force of superior numbers than to Spanish promises. In so acting the Cuban chiefs saved their country unnecessary carnage, and the renewed horrors of an unequal struggle; the sorrowful events of the Ten Years' War were still fresh in their memories. "The Little War" ended, the Spanish Government continued uninterruptedly in its perfidious policy. To reinforce all the springs of its domination was its one constant preoccupation. The modest reforms, of which mention has been made. were transformed by manipulation and through the decisions of the Captain-General, into mere shadows of what had been intended.

With the patience and skill of a spider, Spain spun a stifling net, political and financial, all around the island. Corruption again openly flourished in every branch of the Administration, comparable only to that existing in the worst days of the Roman Empire. A market was instituted where official positions, as well as decrees of the courts, were bought and sold at public auction. The Ministry of the Colonies at Madrid was but a great business agency, the Captain-General and the heads of the departments being the brokers in the universal sale. The Archbishop, the Bishop, the priests, the military commanders, the mayors of the differenr cities, the members of the Executive Committee of the Provincial Councils, the *employés*, and even the police, were all chosen by the Government from among the highest bidders. Even the appointment of the Captain-General was no exception to this rule. The results of acquiring official positions by this method can be easily imagined. The principal care of the newly appointed was, firstly, to recover the price paid for their positions; secondly, to amass in short spaee a fortune whereon to live comfortably at home, in Spain, enabling them thereby to win influence among their astonished and less fortunate fellow-citizens. Everything having a vicious, immoral, and degrading tendency was fostered by the Government in order to corrupt the bodies, minds, and consciences of the people, thus diverting them from all consideration of politics, and from their ideals of independence. The Spaniards knew perfectly well that an immoral and debased country is incapable of carrying out a lofty mission. Sacred causes and high ideals require a pure and honest people. The most absorbing centralisation in all matters was established. The town councils and the provinical assemblies were deprived of all initiative, and the approval of the Captain-General or of the Minister of the Colonies was necessary even for the foundation of a school or the choice of a professor.

Every imaginable obstacle was placed in the way of business enterprises, which, coupled with the enormous taxes imposed upon them generally, led in many cases to their complete extinction. No progress in any direction was possible. In order to be the better able to watch the movements of the Cubans, the island was covered with military posts, and blockhouses were everywhere erected. The duty of the garrison of these forts was to interfere day and night in the affairs of the country people, whose liberty of action and even of social intercourse was restricted to the uttermost. Hideous outrageous and foul murders, due to the soldiery, were not rare occurrences, the perpetrators, as a rule, remaining undiscovered and unpunished. Even if the representatiions made by the relatives of the victims, backed by some man of influence, and supported by an autonomist newspaper resulted in an investigation, the culprit, if discovered, generally escaped punishment. The court always found some pretext for acquitting the accused, or at least of delaying the trial indefinitely.

The murder of La Rosa and that of Colza at Mariel, Pinar del Rio Province, offer good illustrations of the usual course of action in such matters. In the case of the former, the military commander and the mayor of the village where the crime was committed were convicted, but punishment of the offenders was indefinitaly postponed. The reason for the assassination of La Rosa was no other than his being the lover of a woman desired by the military commander. Many such examples could be given. Another case where the criminal escaped was that of Dr. Jeronimac Rodriguez, Mayor of Tapaste, convicted of fraud and perjury in the municipal elections.

The spirit of disaffection towards Spain was daily growing more intense. Patriots of mature experience could hardly restrain the impatience of the younger men desirous of taking arms in certain localities. In 1885, a fresh revolt broke out in the provinces of Sta Clara and Santiago de Cuba. But the state of unpreparedness of the Cubans again militated against their success. Fresh atrocities and cruelties were constantly being committed about this time by order of the Captain-General, Blanco. General Polavieja, Military Commander of Santiago de Cuba Province, killed in cold blood thousands of defenceless Cubans. All those suspected of being connected with the revolutionary movemeut were taken from their homes in the dead of night, embarked on Government ships, and thrown into the sea. Elsewhere, others were assassinated at cross-roads or in the ditches of the fortress. Not one of them was ever submitted to trial.

When, on the failure of this last gallant enterprise, the Cubans surrendered their arms on condition that they should be allowed to leave the island without molestation, the fate of the unfortunate leader, General Seyte Vidal, is one of the best proofs that could be brought forward of the vaunted generosity and chivalry of General Blanco, the man who is still nominally Captain-General of Cuba. On the eve of his departure, Seyte Vidal was invited to dinner by the Military Commander of Guantanamo. The banquet being over, Vidal entered a steam-launch belonging to a Spanish man-of-war which was to convey him to Kingston, according to the agreement entered upon with the Government, but on his way to the ship he was killed by the crew acting under General Blanco's orders.

Similar acts of treachery could be cited in such numbers that, notwithstanding their horror, they become monotonous in repetition, save to those who have suffered from them in one way or another, in spite of the inventive faculty displayed by the Spaniards in this respect. Indeed, they can scarcely be credited, except by those who have lived in Cuba; therefore it is necessary to give names and data whenever possible, in order not to leave one's self open to the suspicion of exaggeration or invention.

The tyrannous methods restored to by the Government in the management of the finances, coupled with the production of beet sugar in Europe, especially in France, Germany and Belgium, led to an economical crisis lasting from the year 1889 to 1892. So depressed became the market in sugar that there ensued a real panic in the business world, for sugar-cane was the staple production of the island. Little by little, Cuban sugar was driven from the European markets, the United States remaining the only customer. As a further aggravation of the existing situation the McKinley tariff was imposed. General bankruptcy was imminent, and every branch of business in the island being menaced with ruin, men of all parties raised a cry of alarm. So threatening was the danger that, for the moment, Cuban and Spaniard put aside their old hatreds in order to attempt a common salvation. Meetings were held everywhere to discuss the economical problem. Committees were formed in all the large cities, the better to direct public opinion towards the consideration of the financial reforms necessary in the administration. But the Government, always suspicious, and fearing the consequence of the union of Cuban and Spaniard, although such union were for economic purposes only, nipped in the bud all such plans and destroyed all hope of amelioration. A monster mass-meeting, with delegates from all the provinces, was to have been held in Havana to pass resolutions regarding the needed reforms, but the Captain-General openly prohibited it. Threats and bribes were then employed in order to cause the withdrawal of the Spanish element from the movement, being regarded by the authorities as endangering the sentiment of nationality, and likely to engender opposition to the Central Government. Consequently the movement lost vitality, and those who had resisted governmental interference were utterly defeated at the next elections. The stupidity as well as the iniquity of this proceeding on the part of the Government need not be commented upon. It was, however, consistent with the whole policy of Spain, to divide in order to hold.

Thus did political and financial oppression combine to exhaust all the fountains of prosperity and annihilate all prospect of progress. In vain did the Autonomist party insist upon the necessity of reform in every branch of the administration; no heed was paid to their demands. Again, no way presented itself out of the ever-growing difficulties, save revolution. The Autonomist party lost its cohesion; the electors, speaking generally, no longer troubled to go to the polls, regarding it as a farce. The provincial committees of Santa Clara, Santiago de Cuba, and Puerto Principe refused obedience to the Central Committee of Havana, where a dozen of its members diligently

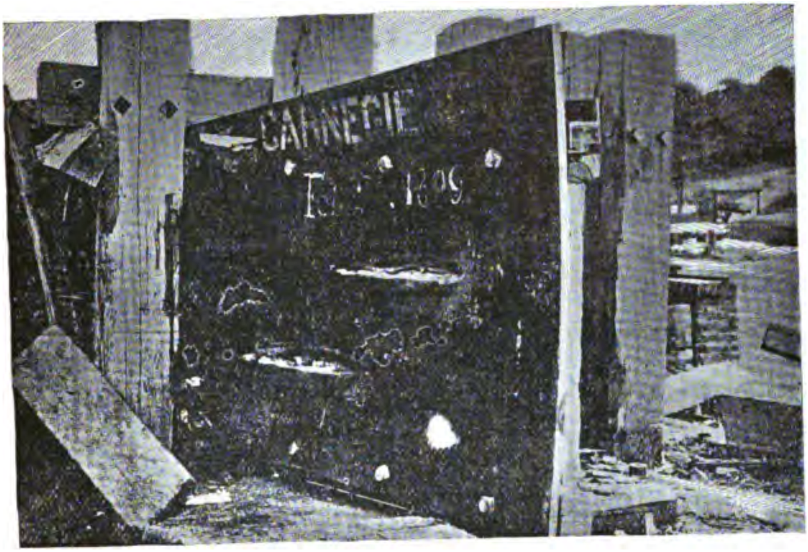

CARNEGIE
1899

FIG. 1.

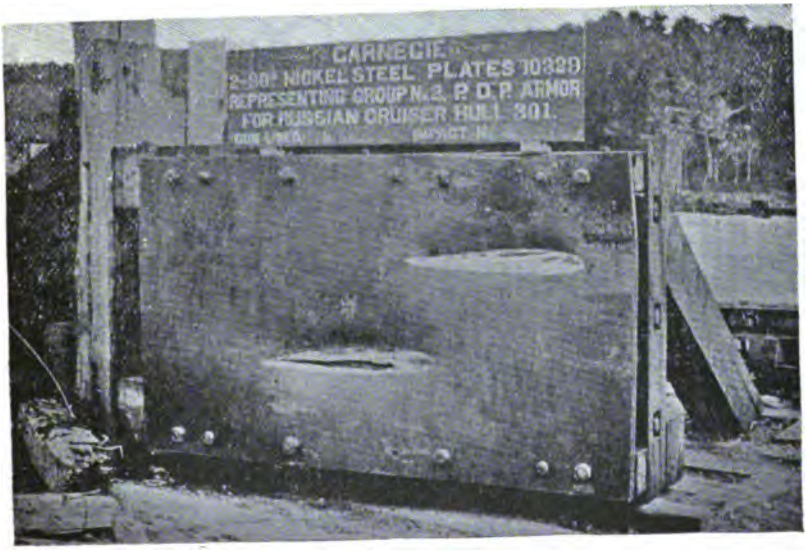

CARNEGIE
2-90? NICKEL STEEL PLATES 10329
REPRESENTING GROUP N. 2. P. O. P. ARMOR
FOR RUSSIAN CRUISER HULL 301.
IMPACT N.

FIG. 2.

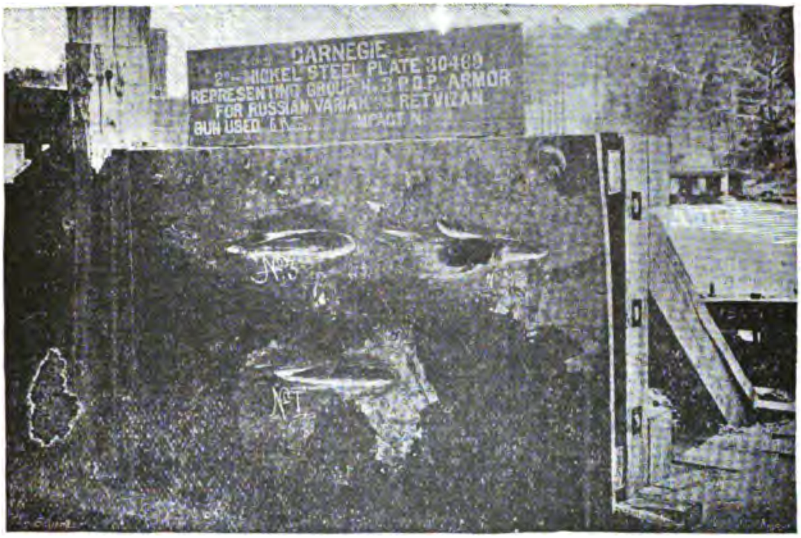

CARNEGIE
2" NICKEL STEEL PLATE 30469
REPRESENTING GROUP N. 3 P.D.P. ARMOR
FOR RUSSIAN VARIAK & RETVIZAN
GUN USED 6 N.
IMPACT N.
No 3
No 1

FIG. 3.

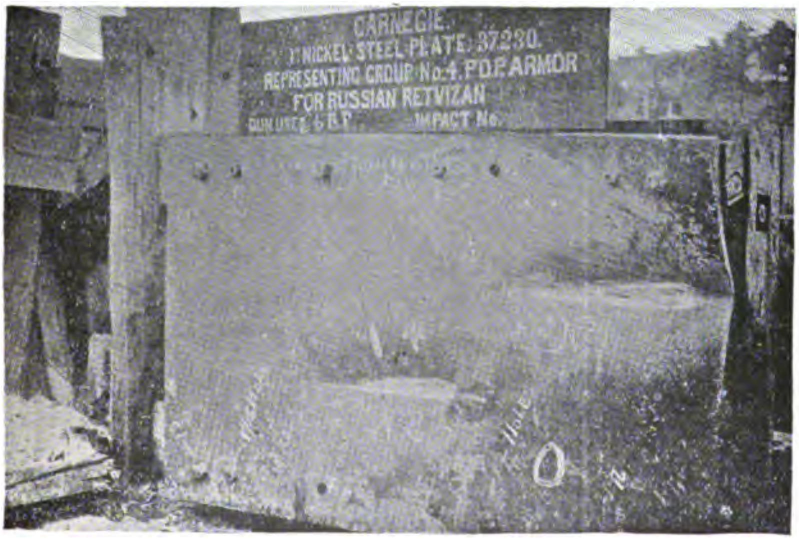

CARNEGIE.
1" NICKEL STEEL PLATE 37230.
REPRESENTING GROUP No. 4. P.D.P. ARMOR
FOR RUSSIAN RETVIZAN
GUN USED 6 B.P.
IMPACT No.

FIG. 4.

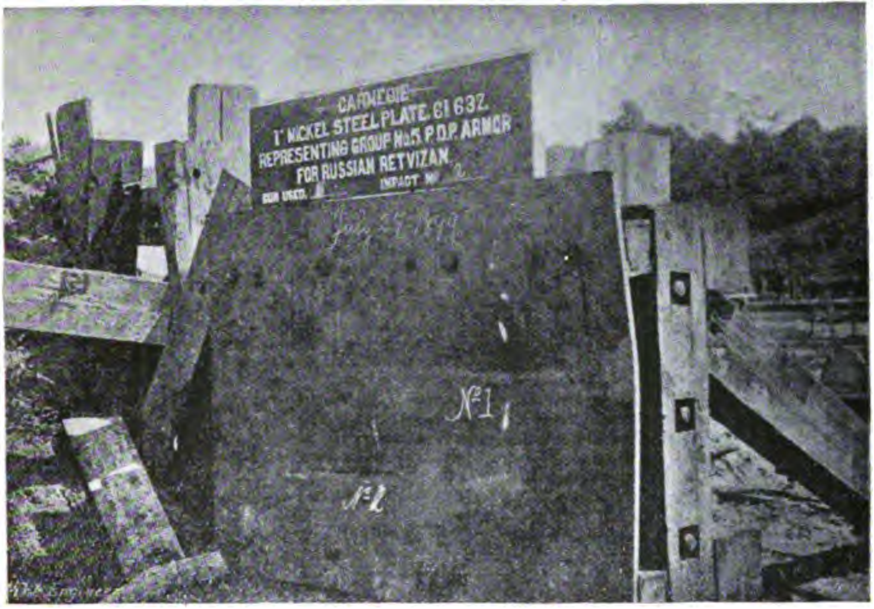

CARNEGIE
1" NICKEL STEEL PLATE 61632
REPRESENTING GROUP No. 5 P.D.P. ARMOR
FOR RUSSIAN RETVIZAN
GUN USED
IMPACT No. 2
July 25 1899
No. 1
No. 2

FIG. 5.

manufactured Spanish politics in exchange for official positions, either for themselves or their relatives.

The disaster that has since overtaken Spain might still have been averted had the Cortes listened willingly to the suggestions of one or two of the more enlightened of her sons, but Spain marched stubbornly to her doom. In the spring of 1894, the Minister of the Colonies, Señor Maura, introduced into Parliment a Bill of reforms, which was favorably received by the majority of the Cubans. However, being furiously attacked by the Conservative party, and not sufficiently supported by the Premier, Señor Sagasta, it failed to pass. The failure of the Maura Bill caused great excitement in Cuba. It sounded the death-knell of hopes long clung to, and justice delayed. Even the most Conservative of the Cubans began to despair of the future. In place of the Maura Bill was substituted the Abarzuza Bill, which was but a gross caricature of the former. In fact, the secret purpose of Spanish politicians in passing this measure was to render the Cubans responsible for the enormous debt created by Spain. Under the pretext of reform the wily Spanish fox endeavored to enchain the future of Cuba and to hold her bound at the feet of the European holders of Cuban bonds.

Yet Spain was not to see her wishes gratified, for the Abarzuza Bill, being promulgated in the month of January, 1895, on the 24th of February following the Cubans once more unfurled the banner of independence. The proportions that this last revolution has since assumed prove how strong and deep-rooted was the resistance to Spanish domination. After three long years of heroic struggle, the United States at length awoke to the horrors of the conflict taking place near her southern shores, and infuriated at the loss of the Maine, extended her powerful aid to the Cubans. Henceforward Spain no longer exists but as a name in that New World which once was hers entirely.

For Cuba a new day has dawned; a new Republic will soon join in the concert of the free nations of the earth.

—*United Service Magazine*, January, 1899.

ARTILLERY MATERIAL.

Carnegie Thin Krupp Armor for Russia.

The photographs reproduced here show the effect of two or three glancing rounds in each case fired to test the thin protective deck plates furnished by the Carnegie Steel Company to Russia. The Krupp process did not find its way to America till about a year after it came to us, so that the trials hitherto have chiefly been with experiental plates. These before us relate to a supply of Krupp process plates of a hard quality but not with hardened faces. This is necessarily the case with plates below four inch or five inch thickness. The easiest thickness of plate to treat completely by this process is about six inch. This plate becomes contorted in the face hardening, and very thick plates are naturally more difficult to manufacture. We may congratulate ourselves on having manufactured six inch plates in time to meet the demand for the quick-firing gun batteries of our recent ships. It may be observed that in such a course the difference in protection between quick-firing guns behind six inches of armor and, say four inches, is not simply the difference in resisting power due to the difference in thickness, great as this is, but between hard-faced six inch steel and ordinary four inch, We need hardly say that 15 deg. with the deck represents an angle that can hardly occur on service, because a battleship is not likely to be under fire when her deck heels over to anything approaching that angle, and the coast forts that possess the command to give so plunging a fire at a probable fighting range are indeed few. The particulars of the plates are as follows:

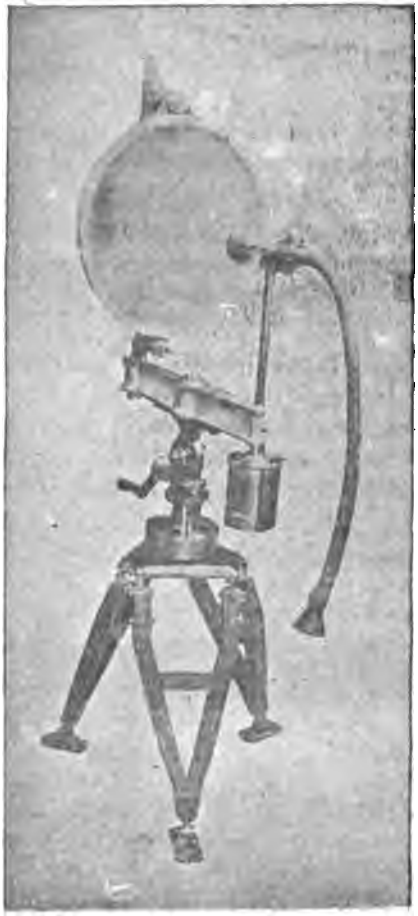
Figure 1 is a plate 1½ in. by 93 in. by 68·5 in. by 58·5 in., representing a first lot of protective deck plates for the cruiser Variak. The attack was made by a 6 in. gun firing a Carpenter 6 in. armor-plated shell. The striking velocity was 1321 foot-seconds. Figure 2 shows two nickel steel plates for the same purpose bolted together, and attached in the same way, but with a striking velocity in the second round of 1160 foot-seconds. The plate was so placed in a vertical plane that the angle between that plane and a vertical plane through the line of fire was 15 deg. The outer plate was cut through for a length of 26 in., the opening being 1½ in. wide at its middle part. The second plate was not cut or scarred. Figure 3 represents a 2 in. nickel steel plate for protective deck of Variak and the battleship Retvizan. The same gun and projectile were used. In the third round the striking velocity was 1639 foot-seconds. An indentation, about 3 in. wide by 26 in. long, was made in the plate. The estimated penetration was 1·3 in. There was a through crack at the bottom of the indentation, 19½ in. long, but no other damage to the plate or structure. Figure 4 was protective deck plating for the Retvizan. It was 1 in. thick, and the attack was as before, the striking velocity for round 2 being 1026 foot-seconds. An indentation 3 in. wide, 24 in. long, and 2·75 in. deep was made, but the plate was not cracked. The estimated penetration was ¼ in. The plate was placed similarly to No. 2. Figure 5 is also from a 1 in. plate from the Retvizan. The striking velocity was in the second round 1039 foot-seconds. An indentation 4 in. wide, 4·5 in. deep by 32 in. long, was made. At the bottom of this indentation was a crack 28 in. long by 1½ in. wide at the centre. The plate was reduced to a thickness of ⅜ in. at the edge of the crack. The angle of fire was 15 deg. from the horizontal.

—*The Engineer*, October 20, 1899.

Cowper-Coles' Sound Locator and Projector.

This instrument, of which we annex an engraving has been designed by Mr. Sherard Cowper-Coles, of Grosvenor Mansions, Victoria street, London, S. W., for the purpose of readily locating the direction of a sound, and for projecting sound long distances. The instrument consists of a reflector, mounted on an arm which can be readily turned on its centre, and depressed or elevated by the operator. When it is desired to ascertain the exact direction from which a sound emanates, the apparatus is turned on its axis, and as soon as the reflector is opposite the source of sound it is heard much intensified in the receiver.

When it is desired to carry on a conversation between two distant ships or points, two instruments are used, so that the beam of sound is thrown from one reflector to the other, the sound being focussed in one instrument in the receiver; one operator speaks into the flexible tube, while the operator working the other instrument places the tube attached to the receiver to his ear. Conversation can thus be carried on at long distances without unduly raising the voice.



Experiments have recently been made with this apparatus at St. Margaret's Bay, near Dover, when satisfactory results were obtained. It was found that even the ticking of a watch when placed in the focus could be heard by observers at a distance of some 20 feet, although there was a strong wind blowing across the line of direction of the sound at the time.

—*Engineering*, October 20, 1899.

WARSHIPS AND TORPEDO BOATS.

Germany.

Last year some particulars were given of the Naval Defence Act, or Sexennate, under which the German Navy is being increased upon a fixed and definite plan. Owing to the action taken by the Clerical Party and the Budget Committee in the Reichstag, it was finally decided to spread the expenditure over a period of six years instead of seven, as orginally contemplated, viz., 1898–1903 inclusive. The final acceptance of the new law, which was promulgated on April 10th, 1898, gave the greatest satisfaction to the Emperor and to the Navy at large. The following are the details of the measure. The German Fleet, exclusive of torpedo-boats, training-ships, special service vessels, and gunboats, is to be formed thus :—

Active List. 1 Flagship (battleship).
2 Squadrons, each of 8 battleships.
2 Divisions, each of 4 coast-defence ships.
6 Large cruisers } for the Home Squadron.
16 Small cruisers }
3 Large cruisers } for Foreign Service.
10 Small cruisers }

Reserve. 3 Battleships.
3 Large cruisers.
3 Small cruisers.

The ships completed or in hand on April 1, 1898, and accepted as forming part of this prescribed establishment, were 12 battleships, 8 coast-defence ships, 10 large and 23 small cruisers, but some of these will pass out of the active category before the expiration of the Sexennate, and within the period of six years other battleships and cruisers are to be laid down and completed to make up the legal number. The principles regulating the supersession of ships considered to be antiquated are laid down in the Act. The active life of a battleship or coast-defence vessel is reckoned at twenty-five years, of a large cruiser at twenty years, and of a small cruiser at fifteen years, these periods being counted from the date of the first credit for the building of any particular ship up to the same grant for the laying down of her successor.

The shipbuilding program of 1898 included votes for the completion of the battleship *Kaiser Frederick III.*, of the second-class cruisers *Hansa* and *Vineta*, of the smaller cruiser *Gazelle*, and the gunboats *Jaguar* and *Iltis*; for the continuation of work upon the battleships *Kaiser Wilhelm II.* and *Ersatz König Wilhelm*, and the armored cruiser *Fürst Bismarck*; and for the laying down of two battleships, "A" and "B," a larger cruiser, "A," the small cruisers "A" and "B," two gunboats, *Ersatz Wolf* and *Ersatz Habicht*, one torpedo division boat, and certain torpedo-boats, as well as for completing the reboilering of the ships of the *Sachsen* class.

Five vessels were launched in the year 1898—the cruiser *Hansa* at Stettin (*Vulcan*); the *Gazelle* (*ex* "G"), at the Germania Yard of Herr Krupp, Kiel; the gunboats *Jaguar* and *Iltis* (*ex Ersatz Hyäne* and *Ersatz Iltis*), at the Danzig Yard of Herr Schichau; and the destroyer "*D* 10," built by Messrs. Thornycroft at Chiswick.

The second-class cruiser *Freya* has been fitted with Niclausse boilers, and her sister ships the *Hertha* and *Hansa* with Belleville, and the *Victoria Luise* with Dürr boilers. Considerable interest will therefore attend the performances of these vessels, although, as will be seen, the Dürr boiler has already been adopted for several important ships. The speed of these cruisers is 20 knots with 10,000 I. H. P., but the *Freya* developed 10,500 I. H. P. with a mean speed of 20 knots at her second trial.

The *Hertha* is a second-class cruiser, with steel hull, 344 feet 6 inches long, 57 feet beam, 21 feet 8 inches draught, 20 knots speed; her armament consists of 2 8.2 inch quick-fire guns, 8 6-inch, 10 3.4-inch, 10 1.4-inch and 4 Maxims. She has 3 torpedo tubes; and her protection is 4 inches of armor in gun position, and 4 inches deck protection.

The torpedo division-boat or destroyer, which Messrs. Thornycroft have built, displaces 310 tons, and is therefore smaller than some of the Elbing boats, but she is longer, built upon finer lines, and much swifter. According to contract she is to steam at 27·5 knots in German waters, with German engineers and stokers. The trial on the Maplin Sands was satisfactory, the boat attaining a mean speed of 28·545 knots, with a load of 85 tons on board.

—*Brassey's Naval Annual*, 1899.

The Vulcan Works at Stettin.

Some reference may now be made to warships constructed in recent years. We have tabulated the leading dimensions of the more important, and from this table it will be seen that they include every type, incuding 10 battleships, one armor-clad cruiser of 9850 tons, seven protected cruisers, six unprotected cruisers, one torpedo cruiser, and one gun-boat. We have not included in the list torpedo craft, of which 33 have been built ranging up to 23 knots speed.

The most notable of the warships is probably the Imperial yacht *Hohenzollern*, which is fitted as an auxiliary cruiser. She is a magnificent specimen of naval architecture alike in her fighting qualities and appointments, the decorations being very fine. She is of 4180 tons displacement, and her engines, of 9500 indicated horse-power, give her a speed of 22 knots, and she carries three 10.5-centimetre guns, and twelve 4.7-centimetre, all quick firers.

The latest of the battleships for the Imperial Navy of Germany is illustrated herewith. The engraving shows the *Weissenburg* steaming 16½ knots on her trial trip. The principal dimensions are as follow: Length 354 feet 6 inches; beam. 64 ft., draught of water, 24 ft. 8 in. The hull is of steel, with double bottom, and the ship is divided into 120 watertight compartments. Further protection is provided by a 15¾-in. compound armor belt, supported by an 8-inch. teak backing on the Krupp system, in way of the vital parts, and by a 2½-in. steel deck right fore and aft. She is fitted with triple-expansion engines to work to 9500 horse-power, and realized a speed of over 16½ knots on trial. The armament consists of six 28-centimetre guns, mounted in pairs, in three barbettes, six 10½-centimetre (4-in.), and eight 87-millimetre (3½-in.) quick-firing guns, besides lighter machine-guns mounted in the military tops. She is fitted with several torpedo-launching tubes. The three barbettes are placed in the centre line of the ship, but the fore-turret is elevated on a lofty superstructure which extends for almost half the length of the ship. Abaft the foreturret is the battery for the 4-in. quick-firing guns, protected by thin armor to exclude explosives and shot. The foremast and funnels are within the battery, abaft which the deck is lower; the main mast is between the centre and after barbettes. The 3½-in. quick-firing guns are mounted on bridges forward and aft and between masts. The vessel carries two steam vedette boats, besides 12 other boats. She is heated by steam and lighted by electricity.

For the Chinese Government the Vulcan Company have built a large number of warships, and of a recent type, the protected cruisers *Hai Yung*, *Hai Shew*, and *Hai Shen*. These vessels are 328 ft. long by 41 ft. beam, with an extreme draught of 16 ft. 6 in., at which the displacement is 2950 tons. The protective deck varies in thickness between 1½ in. and 3 in., and the coal bunkers, with capacity for 500 tons, are arranged on either side of the machinery. The guns, too, are protected by steel shields. The engines of the triple-expansion type develop 7500 indicated horse-power, and give the

WARSHIPS BUILT OR BEING BUILT AT THE VULCAN WORKS (EXCLUSIVE OF TORPEDO-BOATS.)

Name.	Year.	Dimensions.		Speed.	Armament.
		Length between perpendiculars. metres	Breadth. metres		
Germany.					
Armor-Clads.					
Preussen	1876	93.60	16.32	14.0	Four 26cm.; two 17cm.; four 8.7cm.; six Mitr.
Sachsen	1878	91.00	18.30	14.0	Six 26cm.; four 10.5cm.; six Mitr.
Würtemberg	1881	91.00	18.30	14.0.	Six 26cm.; four 10.5cm.; six Mitr.
Oldenburg	1884	75.00	17.20	13.5	Eight 24cm.; four 15cm.; six Mitr.
Brandenburg	1893	108.00	19.5	16.5	Six 28cm.; six 10.5cm.; eight 8.7cm.; six Mitr.
Weissenburg	1894	108.00	19.5	16.5	Six 28cm.; six 10.5cm.; eight 8.7cm.; six Mitr.
Protected Cruisers.					
Irene	1887	94.00	14.00	18.0	Fourteen 15cm.; eight Mitr.
Hertha	1898	105.00	17.40	19.5	Two 21cm.; eight 15cm.; ten 8.8cm.; ten 3.7cm.; eight Maxim guns; 3 submerged torpedoes.
Hansa	1898	105.35	17.63	19.0	
Cruisers.					
Leipzig	1877	82.23	14.00	15.0	Twelve 17cm.; six Mitr.
Prinz Adalbert	1877	82.23	14.00	15.0	Twelve 17cm.; six Mitr.
Stosch	1879	71.67	13.75	13.5	Sixteen 15cm.; two 8.7cm.; 6 Mitr.
Stein	1880	71.67	13.70	13.5	Sixteen 15cm.; two 8.7cm.; 6 Mitr.
Carola	1881	69.00	12.50	14.0	Eight 15cm.; two 8.7cm.; 4 Mitr.
Olga	1881	69.00	12.50	14.0	Eight 15cm.; two 8.7cm.; 4 Mitr.
Imperial Yacht.					
Hohenzollern	1893	116.60	14.00	22.0	Three 10.5cm.; twelve 4.7cm.
Gunboat.					
Comet	1893	71.35	9.20	20.00	Four 8.7cm. and three torpedo tubes.
China.					
Armor-Clads.					
Ting Yuen	1883	91.00	18.30	14.5	Four 30.5cm.; two 15cm.; 8 Mitr.
Chen Yuen	1884	91.00	18.30	14.5	Four 30.5cm.; two 15cm.; 8 Mitr.
King Yuen	1887	79.40	12.00	16.0	Two 21cm.; two 15cm.; 7 Mitr.
Lai Yuen	1887	79.40	12.00	16.0	Two 21cm.; two 15cm.; 7 Mitr.
Protected Cruisers.					
Tsi Yuen	1883	72.00	10.50	15.00	Two 21cm.; one 15cm.; 9 Mitr.
Hai Yung	1898	96.00	12.5	20.75	Each ship three 15cm.; eight 10.5 cm.; six 3.7cm.; 6 Maxim; one 6 cm. boat gun; 3 torpedo tubes.
Hai Shew	1898	96.00	12.5	20.75	
Hai Shen	1898	96.00	12.5	20.75	
Torpedo Cruiser.					
Fey Ying	1895	75.00	8.70	21.25	Two 10.5cm.; six 4.7cm.; four 3.7 cm.; and three torpedo tubes.
Japan.					
Armored Cruiser.					
Yakumo	..	124.20	19.60	20.0	Four 20cm.; 12 15cm.; 12 7.5cm.; 7 4.7cm.; 4 submerged broadside torpedoes; 1 above-water bow torpedo.
Russian.					
Protected Cruiser.					
Bogatyr	..	126.00	16.60	23.0	Twelve 15cm.; twelve 7.5cm.; six 4.7cm.; and six torpedo tubes.

ship a speed of 20¾ knots. The armament consists of three 5.9-in. and eight 4-in. Krupp quick-firing guns, with six 1.4-in., Hotchkiss quick-firers, and six Maxims, while there are three submerged torpedo tubes. For the same Navy the company recently built a torpedo cruiser of 850 tons, which steamed 21¼ knots.

Amongst the Japanese warships is the *Yakumo*, an armored cruiser of 9850 tons in displacement. The length is 480 ft., the beam 64 ft., and the draught 23 ft. 9 in. The vessel has a belt of 6-in. armor, with a 3-in. protective deck stopping well below the water line. Her engines will develop 16,000 indicated horse-power, and the speed will be 20 knots. She will have four 8-in., twelve 6-in., and twelve 2.9-in. quick-firers, with four submerged and one above-water torpedo tubes, so that she will be a formidable cruiser. As the leading dimensions of the principal warships are give in the table, it is scarcely necessary to deal further with these.

—*Engineering*, August 11, 1899.

BOOK REVIEWS.

Alloys ot Iron and Nickel. Robert Abbott Hadfield. Proceedings of The Institution of Civil Engineers. Edited by J. H. T. Tudsbery, Secretary. London: Published by the Institution, Great George Street, Westminster, S. W. 1899. Pp. 140.

The author of this interesting paper has here added another to his valuable series of investigations on iron alloys, all of which are standard works of reference and authority on the subjects treated. His preceeding articles consider the effects of manganese, silicon, aluminium and chromium in irons and steels. In all his researches his effort has been to make each as complete as possible and constitute a correct and accurate compendium of the subject, and this, his latest work certainly meets his own expectations.

After discussing a number of physical data relating to nickel and iron, the author explains how his own test specimens were prepared, and then gives the results of his investigations on cast and on forged nickel-iron alloys, annealed and unannealed.

In discussing the results upon the tensile tests the author makes this important statement:

"As already pointed out, it is probable that the special advantage of the use of nickel is due not so much to the properties it confers upon iron in carbonless, or nearly carbonless, iron alloys, but to its modifying influence upon iron in the presence of carbon when it probably forms a special carbide of nickel. In the latter case it is hardly probably that high percentages of nickel will be required for uses to which steel is now applied. This theoretical opinion can only be accurately determined by the preparation of say, ten specimens to each of the Author's nickel percentages, the carbon varying, say, by tenths. This would mean the production of about 140 different specimen alloys. As each of these specimens would require about 500 to 600 separate tests of various kinds, it will be seen that the work would require close application to even complete it in a lifetime. The Author gives this illustration to show the difficulty attending a complete solution of alloy questions. It ought also to show how exceedingly careful each experimenter should be in describing a new alloy or product. No one specimen means finality or is any indication of what a definite arrangement of other proportions may give."

Besides the tensile tests, the specimens were submitted to compression tests and bending tests, tests by cooling, welding tests and self-hardening tests, and the magnetic properties were also fully investigated.

Part II discusses the subject of nickel-steel and its uses, and in this section the author remarks in regard to its use as a gun-steel:

"*Gun Steel.*—There is no doubt that a steel of high elastic limit, combined with ductility, is of great importance for this purpose. Naturally the high and repeated stresses occuring in modern artillery seriously fatigue steel of comparitively low elastic limit. The addition of nickel enables a tougher steel to be used, and this, without the corresponding loss of elastic limit met with in milder carbon steel."

As regards the effect of nickel upon iron, and the part played by carbon in such alloys, this little work adds very much to our present knowledge of the chemistry of this subject. We quote a few statements in illustrations:

VIBRATIONS OF DIFFERENT POINTS OF A RIFLE BARREL.

The vertical line γ marks the instant the projectile leaves the muzzle.

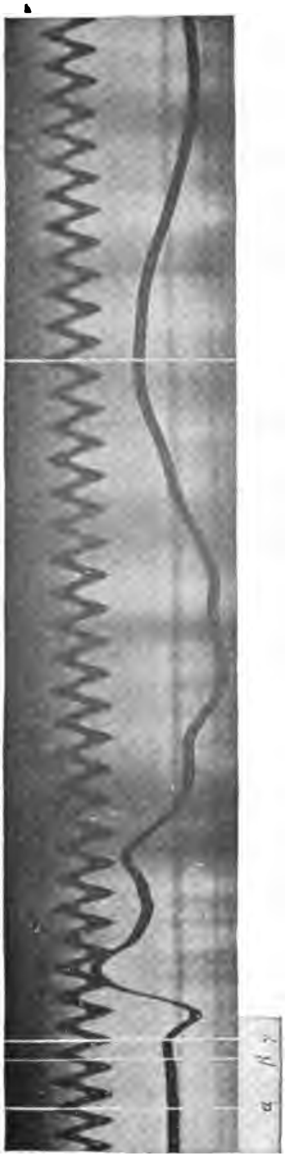


Fig. 1. — Curve of vibration of a point 1.5 cm. from muzzle.

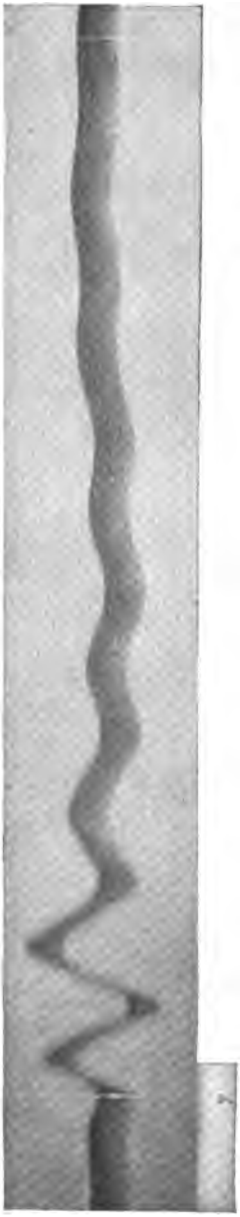


Fig. 2. — Curve of vibration of a point 55.0 cm. from muzzle.

VIBRATIONS OF DIFFERENT POINTS OF A RIFLE BARREL.

The vertical line γ marks the instant the projectile leaves the muzzle.

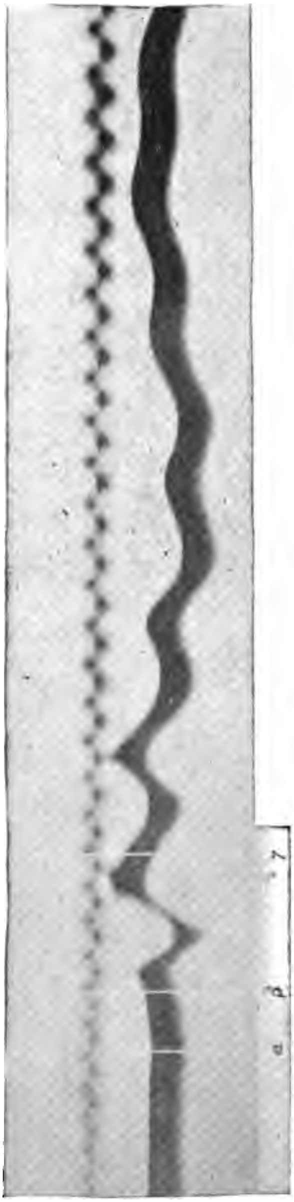
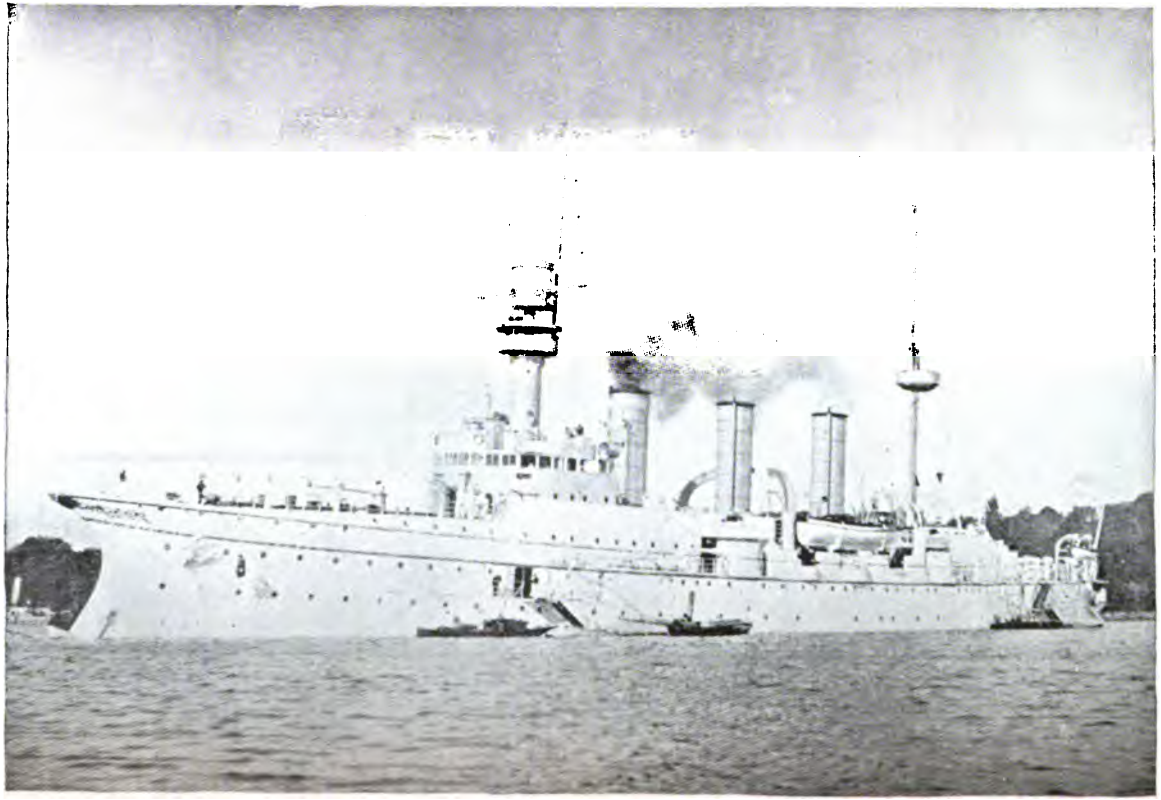


Fig. 7. — Curve of vibration 1.5 cm. from muzzle: with one-eighth charge.

The Imperial German Battleship WEISSENBURG.



The Tripple-Screw German Protected Cruiser HERTHA.

Cassier's Magazine.

"The fact that nickel raises the elastic limit of steel is easily proved, but to give a reason for this effect, which can be definitely proved, would be difficult. The best explanation is that it strengthens the cementing material up to a certain point (20 per cent.), and holds in a more rigid matrix the iron crystals which in nickel-steel exist in smaller aggregations; beyond this the cementing material is not so much strengthened as it is toughened, which accounts for the abnormal increase in elongation.

"Whether the action of nickel is direct or indirect has not yet been determined. The author is inclined to believe that its influence in medium and high carbon steel is rather in the direction of causing a more intimate combination between carbon and iron, and that the use of nickel is to toughen the matrix of the iron.

"It is found, however, that when carbon is also present in nickel-steel it does not interfere in any way with the usual combination of carbon and iron. Whether a triple compound is formed is not certain. It is quite possible that a carbide of nickel is formed in the same manner as carbide of iron, and that this is the particular formation which offers the special characteristics met with in nickel-steel. It is almost certainly proved by Mr. J. E. Stead's valuable investigations that there is a double carbide of iron and manganese, and it is therefore probable that there is a carbide of iron or a double carbide of iron and nickel."

Part III contains the early history of nickel, and an account of its compounds and ores.

The whole is a compendium of the best knowledge of the subjects and constitutes an authoritative work by one of the most conscientious and able investigators of our day.

J. P. W.

Untersuchungen ueber die Vibration des Gewehrlaufs von C. Cranz und K. R. Koch. I. Schwingungen in verticular Ebene bei horizontal gehaltenem Gewehr. A. Gewehre von Typus des Mausergewehrs Modell 71. Muenchen: J. Roth. 1899.

The investigations of Professors Cranz and Koch on the vibrations in the vertical plane of the barrel of a rifle held horizontally constitutes a noteworthy addition to the general subject of ballistics.

The cause of the so-called *jump* of rifles, that is, the angular difference (in a vertical plane) between the direction the projectile actually takes on leaving the muzzle of a gun and the direction it would have taken had it gone exactly as it was aimed, or, in technical language, the difference between the angle of elevation and the angle of projection, has long been veiled in mystery. The able investigators named above have undertsken the investigation of this subject, and have come to the conclusion that it is due to the vibrations set up in the gun barrel at the moment the gun is fired.

It will be remembered (see *Journal U. S. Artillery*, Vol. IV, No. 4, October, 1895), that Professor Crehore and Lieutenant Squier, in their investigations on a photographic method of determining the complete motion of a gun during recoil, came to the following conclusion: "It may be said, therefore, that a Springfield rifle *does not move appreciably* before the bullet leaves the muzzle. Even if the motion were appreciable, its direction is such that it is parallel to the axis and *does not effect the aim of the gun.*" Professors Cranz and Koch come to a very different conclusion, and their data for this conclusion are presented graphically in the reproduced photographs herewith, of which the original article has many more.

Their method of procedure was similar to that of Professors Crehore and Squier. To show graphically that there were vibrations and to determine their character, they utilized instantaneous photography, a certain point of the barrel, during the movement of the projectile along the bore and after it left the bore being photographed on a plate, which is moved rapidly past in the plane of the photograph. In this way the progress of the vibration of the point in question is photographed as a curve on the plate. In order to determine the exact time for each position of the point, the vibration of a turning fork (of known rate) is photographed on the plate at the same time, so that by counting the number of vibrations of the turning fork (appearing as a waving line on the plate) the exact times in which the varying positions of the point occur may be readily determined.

The accompanying figures illustrate clearly how reliable and accurate their method was, and also how reasonable their conclusions. Figure 1 shows above the vibrations of the turning fork (the time scale for all the figures), and below the vibration curve of a point of the barrel 1.5 cm. back from the muzzle, the vertical line *y* indicating the instant the projectile leaves the muzzle. Figure 2 shows the vibration curve of a point of the barrel 5.5 cm. back from the muzzle. Figure 3 that of a point 79.5 cm. back from the muzzle, and Figure 4 that of a point 110.5 cm. back from the muzzle. Figure 5 shows the vibrations of a point when the trigger is pulled without having any charge in the gun.

Figure 6 is the vibration of the same point as figure 1, but with only the full charge. Figure 7 the same with only a quarter the charge, and Figure 8 the same with only an eighth the charge. These figures explain how the *jump* varies with the charge, the number of vibrations being greater as the charge is less.

We earnestly recommend this article to all students of ballistics, not only because of its intrinsic value, but also as a splendid example of convincing investigation where actual observation of phenomena is impossible. The work of Professors Cranz and Koch is a classic in its way, and makes a decided step forward in the solution of the intricate problem of the *jump*. Although their investigations so for have been confined to a particular small arm rifle, there is no reason why the conclusions reached should not apply to rifled guns of the largest calibre. The experimenters, however, are not content with this, but propose to continue their work, to determine, if possible, *all* the factors that enter and modify the jump in various pieces of ordnance.

J. P. W.

Tactics for Beginners. By Captain C. M. De Gruyther, Instructor in Tactics at the Royal Military College, Camberley. Aldershot: Gale and Polden Ltd. Pp. 297. Six Shillings.

This excellent résumé of the accepted principles of tactics has been adopted as a text-book for the Cadets at the Royal Military College, Camberly, and is intended to aid officers in their examinations for promotion. The author has selected his material with good judgment, and arranged it in a clear and systematic form, easy of comprehension and handy for quick reference.

The work opens with such simple idea an organization as are essential, and continues with a brief chapter on the time and space relations of the different formations adopted by the three arms; then follows a clear essay on outposts illustrated by a good plate, an interesting article on marches, as well as a presentation of important subjects of advance and rear guards, reports and reconnoissances, all neatly illustrated by useful diagrams; the characteristics and tactics of the three arms are next considered, first separately, then in combination. A most valuable innovation appears in connection with this last chapter, viz: a series of skeleton orders for a field force of all arms under various circumstances. This should constitute a most useful addition to the ordinary text-book.

The work concludes with separate chapters on night operations, villages, woods, rivers, defiles, convoys and savage warfare.

The author has thus touched upon all the essential points of his subject, and while the work is essentially a text-book and does not enter very fully on any subdivision of the subject of tactics, it constitutes an excellent basis for further study and investigation, as well as a useful hank-book for ready reference.

J. P. W.

Organization and Equipment made easy. By Captain S. T. Banning. Aldershot: Gale and Polden, Ltd. Pp. 228. Four-and-six.

The purpose of this little book is to collect in a single volume the information (contained in a great number of official books and regulations) necessary for officers to pass the examination for promotion in this subject. It is practically a *digest.*

While the work is, of course, mainly of interest to the British officer, it also incidentally has a more general interest for the rest of the world in that it gives a very clear conception of the organization and equipment of the British army, which will be of use to all military students.

The appendix contains all the questions thus far set at the examinations in this subject, with complete answers to each. These will offer much food for thought to military students in general, as well as to those directly concerned.

J. P. W.

Key to Military Sketching made easy and Military maps explained. By Captain L. J. Shadwell, D. A. A. G. for Instruction, Kansauli, Punjaub. Aldershot: Gald and Polden, Ltd. Pp. 92. Four shillings.

This work is a key to Colonel Hutchinson's work and was written at Colonel Hutchinson's suggestion. The answers to the questions in the original have been worked out with great care in this book, and the typography, paper and illustrations make the latter a worthy companion of the former.

J. P. W.

C. Julius Caesars Rheinbrücke. Lieutenant P. Zimmerhaeckel. Leipzig: B. G. Tuebner. 1899. Pp. 22, with 31 figures and a plate. 1 Mark.

This interesting essay is an attempt to reconstruct, from the data given in Comm. de Bell. Gall. IV. 17, Caesar's bridge over the Rhine, taking into consideration the material on hand at the point where the bridge was thrown, which the author concludes (with Napoleon III) was at Bonn.

The work is illustrated throughout, and a final plate contains a vertical cross-section and a longitudinal side elevation of the completed bridge.

The paper is, of course, of special interest to the philologist, but it also has considerable interest and value for the military student.

J. P. W.

BOOK NOTICES.

[These books will be fully *reviewed* as space becomes available.]

The Hygiene of the Soldier in the Tropics. Translated by Captain Geo. W. Read, 9th U. S. Cavalry. International Series No. 7, Kansas City, Mo.: Hudson-Kimberly Publishing Co. Pp. 211. $1.50.

Construction der Gezogenen Geschützrohre. Georg Kaiser. 1900. Second edition. Vienna: L. W. Siedel & Sohn. Pp. 419, with 14 large plates of diagrams.

INDEX TO CURRENT ARTILLERY LITERATURE.

PERIODICALS CITED.

Abbreviations employed in index are added here in brackets.

All the periodicals are preserved in the Artillery School Library, Fort Monroe, Virginia.

ENGLAND.

Aldershot Military Society. *Occasional.*
Aldershot. Copies 6d each.

Arms and Explosives. [*Arms and Ex.*] *Monthly.*
Effingham House, Arundel Street, Strand, London, W. C. Per year 7s.

Army and Navy Gazette. [*A. and N. Gaz.*] *Weekly.*
3 *York Street, Covent Garden, London. Per year £*1 12*s* 6*d.*

Canadian Military Gazette. [*Can. Gaz.*] *Fortnightly.*
Box 2179 *Montreal, Canada. Per year* $2.00.

The Engineer. [*Eng.*] *Weekly.*
33 *Norfolk Street, Strand, London. Per year £*2 6*d.*

Engineering. [*Eng'ing.*] *Weekly.*
35-36 *Bedford Street, Strand, London, W. C. Per year £*2 6*d.*

Journal of the Royal United Service Institution. [*Jour. R.U.S.I.*] *Monthly.*,
22 *Charing Cross, Whitehall, London, S. W. Per year* 24 *s.*

Journal of the United Service Institution of India. [*Jour. U. S. I. India*]
Quarterly.
Simla, India. Per year $2.50.

Photographic Journal. [*Photo. Jour.*] *Monthly.*
66 *Russell Square, London.*

Proceedings of the Institution of Civil Engineers. [*Proceedings I. C. E.*]
25 *Great George Street, Westminister, London.*

Proceedings of the Institution of Mechanical Engineers.
[*Proceedings I. M. E.*] 19 *Victoria Street, Westminister, London.*

Proceedings of the Royal Artillery Institution. [*Proceedings R. A. I.*]
Monthly.
Woolwich, England.

Professional Papers of the Corps of Royal Engineers.
[*Prof. Papers Corps Royal Eng'rs.*]
Chatham, England.

Review of Reviews. [*Rev. of Rev. Austral.*] *Monthly.*
169 *Queen Street, Melbourne, Australia. Per year* 11 s. 6 d.

Transactions of the Canadian Institute. [*Trans. Canadian Inst.*]
58 *Richmond Street, Toronto, Canada.*

Transactions of the Canadian Society of Civil Engineers.
[*Trans. Canadian Soc. C. E.*]
Montreal, Canada.

Transactions of the East of Scotland Tactical Society.
[*Trans. E. of S. Tactical Soc.*]
51 *Hanover Street, Edinburgh, Scotland.*

Transactions of the Institute of Naval Architects.
[*Trans. Inst. Naval Architects.*]
5 *Adelphi Terrace, London, W.C.*

United Service Gazette. [*U. S. Gaz.*] *Weekly.*
10, *Wine Office Court, Fleet Street, London, E. C.* *Per year* £1 10 *s* 6*d.*

United Service Magazine. [*United Serv. Mag.*] *Monthly.*
13 *Charing Cross, S. W. London.* *Per year* 27 *shillings.*

FRANCE.

Le Génie Civil. [*Génie C.*] *Weekly.*
6 *Rue de la Chaussée d'Antin, Paris.* *Per year* 45 *Fr.*

La Marine Française. [*Marine F.*] *Semi-monthly.*
26 *Rue de Grammont, Paris.* *Per year* 30 *Fr.*

Mémoires et Compte Rendu des Travaux de la Société des Ingénieurs Civils.
[*Ingénieurs Civils.*] *Monthly.*
10 *Cité Rougemont, Paris.* *Per year* 36 *Fr.*

Mémorial des Poudres et Salpêtres. [*M. Poudres et S.*] *Quarterly.*
Quai des Grands-Augustins, 55, *Paris.* *Per year* 12 *Fr.*

Le Monde Militaire. [*Monde.*] *Fortnightly.*
6 *Rue de la Chaise, Paris.* *Per year* 8 *Fr.*

Revue d'Artillerie. [*R. Artillerie.*] *Monthly.*
5 *Rue des Beaux-Arts, Paris.* *Per year* 22 *Fr.*

Revue de Cavalerie. [*R. Cav.*] *Monthly.*
Berger Levrault et Cie, Rue des Beaux-Arts 5, *Paris.* *Per year* 33 *Fr.*

Revue du Cercle Militaire. [*Cercle.*] *Weekly.*
37 *Rue de Bellechasse, Paris.* *Per year* 27 *Fr.*

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8 *Rue Saint-Dominique, Paris.* *Per year* 27 *Fr.*

Revue d'Infanterie. [*R. Inf.*] *Monthly.*
11 *Place Saint André-des-Arts, Paris.* *Per year* 25 *Fr.*

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11 *Place Saint André-des-Arts, Paris.* *Per year* 25 *Fr.*

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55 *Rue de Chateaudun, Paris.* *Per year* 30 *Fr.*

GERMANY.

Allgemeine Militaer-Zeitung. [*A. M.-Zeitung.*] *Semi-weekly.*
Darmstadt. *Per year* 24 *M.*

Beiheft zum Militaer-Wochenblatt. [*Beiheft.*]
Koch Strasse, 68, *S. W., Berlin.*

Deutsche Heeres-Zeitung. [*Heeres-Zeit.*] *Semi-weekly.*
Wilhelmstrasse 15, *Berlin.* *Per year* $6.00.

Internationale Revue. [*Int. Revue.*] *Monthly.*
Blasewitzer Strasse 15, *Dresden.* *Per quarter* 6 *M.*

Jahrbuecher fuer die deutsche Armee und Marine. [*Jahrbuecher.*] *Monthly.*
Mohren Strasse, 19, *Berlin*, *W.* 8. *Per year* 32 *M.*

Kriegstechnische Zeitschrift. [*Kriegstech.*] *Ten numbers a year.*
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Koch Strasse, 68, *Berlin*, *S. W.* 12. *Per Year* 20 *M.*

Militärische Rundschau. [*Mil. Rundschau.*] *Occasional.*
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Stahl und Eisen. [*Stahl u. Eisen.*] *Fortnightly.*
Schadenplatz 14, *Düsseldorf.* *Per year* $5.00.

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AUSTRIA.

Mittheilungen ueber Gegenstaende des Artillerie und Genie-Wesens.
[*Mitth. Art. u. G.*] *Monthly.*
Wien, *VI*, *Getreidemarkt* 9. *Per year* 1 *Fl.* 50 *Kr.*

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Pola. *Per year* 14 *M.*

Organ der Militaer Wissenchaftlichen Vereine. [*Vereine.*]
Wien I, *Stauchgasse No.* 4 *Per year*, 8-14 *numbers*, 6 *Fl.*

Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines.
[*Z. Architek. Ver.*] *Weekly.*
I. Eschenbachgasse, *No.* 9, *Wien.* *Per year* 10 *Fl.*

SWITZERLAND AND BELGIUM.

Allgemeine Schweizerische Militaer-Zeitung. [*A.S.M. Zeitung.*] *Weekly.*
Basel, *Switzerland.* *Per year*, 8 *Fr.*

La Belgique Militaire. [*Belgique M.*] *Weekly.*
Rue St. Georges 32, *Ixelles*, *Belgium.* *Per year* 12.50 *Fr.*

Monatschrift fuer Offiziere Aller Waffen. [*Monatschr.*] *Monthly.*
Frauenfeld, *Switzerland.* *Per year* 5 *Fr.*, *plus postage.*

Revue de l'Armée Belge. [*A. Belge.*] *Bi-monthly.*
22 *Rue des Guillemins*, *Liège*, *Belgium.* *Per year* 13 *Fr.*

Revue Militaire Suisse. [*R. M. Suisse.*] *Monthly.*
Escalier-du-Marché, *Lausanne*, *Switzerland.* *Per year* 10 *Fr.*

Schweizerische Militärische Blätter. (Including *Schweizerische Zeitschr. für Art. u. G.*, and *Monatschr. für Offiziere aller Waffen*).
[*Schweiz. Mil. Blaetter.*] *Monthly.* *Frauenfeld*, *Switzerland.*
Per year 8 *Fr.* 20 *Cents.*

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Frauenfeld, *Switzerland.* *Per year* 8 *Fr.* 20 *centimes.*

SPAIN, PORTUGAL AND SOUTH AMERICA.

Boletin del Centro Naval. [*Boletin, Argentina.*] *Monthly.*
438 *Alsina, Buenos Aires, Argentina Republica. Per year* $11.00.

Boletin Militar. [*Boletin, Mexico.*] *Weekly.*
Calle de San Rafael 2821, *Mexico. Per year* $6.00.

Circulo Naval,—Revista de Marina. [*Circulo Naval.*] *Monthly.*
Casilla num. 852, *Valparaiso, Chili.*

Memorial de Artilleria. [*M. de Art.*] *Monthly.*
Farmacia, num. 13, *Madrid, Spain. Per year, U. S.,* $3.40.

El Porvenir Militar. [*Porvenir.*] *Weekly.*
258 *Calle Montevideo, Buenos Aires, Argentina. Per year* 10 $ $\frac{m}{n}$.

Revista Cientifico-Militar. [*Cientifico M.*] *Semi-monthly.*
5 *Calle de Cervantes, Barcelona, Spain. Per year* 32 *Fr.*

Revista de Engenheria Militar. [*Engenheria Mil.*] *Monthly.*
27 *Rua Nova do Almada, Lisbon, Portugal. Per year* 1 $ 800 *réis.*

Revista do Exercito e da Armada. [*Exercito.*] *Monthly.*
Largo de S. Domingos No. 11, *Lisbon, Portugal. Per year U. S.* $6.00.

Revista General de Marina, [*R. G. de Marina.*] *Monthly.*
56 *Calle de Alcalá, Madrid, Spain. Price U. S.* $4.45.

Revista Maritima Brazileira. [*R. Marit. Brazil.*] *Bi-monthly.*
Rue do Conseheiro Saraiva n. 12, *Rio de Janeiro, Brazil. Per year* $1.575.

Revista Militar. [*R. Mil. Portugal.*] *Semi-monthly.*
262 *Rua da Princeza, Lisbon, Portugal. Per year,* $2.60.

Revista Militar. [*R. Mil. Brasil.*] *Monthly.*
Rio de Janeiro, Brasil. Per year

Revista Militar y Naval. [*R. Mil. y Nav.*] *Semi-Monthly.*
Calle Colonia, No. 379 *A. Montevideo, Uraguay.*

HOLLAND AND SCANDINAVIA.

Artillerie-Tidskrift. [*Art. Tids.*] *Bi-monthly.*
Stockholm, Sweden. Per year, U. S., $1.75.

De Militaert Gids. [*M. Gids.*] *Bi-monthly.*
De Erven F. Bohn, Haarlem, Holland. Per year, U. S., $2.00.

Militaert Tidsskrift. [*M. Tids.*] *Bi-monthly.*
Copenhagen, Denmark. Per year, U. S., $2.50.

Norsk Militaert Tidsskrift. [*N. M. Tids.*] *Monthly.*
Christiania, Norway. Per year, U. S., $2.50.

RUSSIA.

Artilleriiskii Journal. [*Art. Journal.*] *Monthly.*
Furschtatskaia Ulitza, St. Petersburg, Russia.

Razviedchik. [*Razv.*]
KoloKolwaia Ulitza, No. 14, *St. Petersburg, Russia.*

Russkii Invalide. [*Invalide.*]
Wadizdinskia Ulitza, No. 48, *St. Petersburg, Russia.*

ITALY.

Rivista di Artiglieria é Genio. [*R. Artig.*] *Monthly.*
Tipografia Voghera Enrico, Rome. Per year 30 *L.*

Rivista Marittima. [*R. Maritt.*] *Monthly.*
Rome. · *Per year* 25 *L.*

UNITED STATES.

American Journal of Mathematics. [*Jour. Math.*] *Quarterly.*
John Hopkins University, Baltimore, Md. Per year $5.00.

American Machinist. [*Amer. Mach.*] *Weekly.*
256 *Broadway, New York City. Per year* $3.00.

American Manufacturer and Iron World. [*Man. and Iron World.*] *Weekly.*
55 *Ninth Street, Pittsburgh, Pa. Per year* $4.00.

Annual of the Office of Naval Intelligence. [*Naval Intelligence.*]
Washington, D. C.

Army and Navy Journal. [*A. and N. J.*] *Weekly.*
New York City. Per year $6.00.

Army and Navy Register. [*A. and N. R.*] *Weekly.*
Washington, D. C. Per year $3.00.

Bulletin of the American Mathematical Society. [*Bulletin Math. Soc.*]
University Heights, New York City. Ten numbers per year. $5.00 *per year.*

Cassier's Magazine. [*Cas. Mag.*] *Monthly.*
3, *West* 29*th Street, New York City. Per year* $3.00.

Electrical World and Electrical Engineer. [*Elec. Eng.*] *Weekly.*
9 *Murray Street, New York City. Per year* $3.00.

Electrical Engineering. [*Elec. Eng'ing.*] *Monthly.*
Monadnock Block, Chicago, Ill. Per year $1.00.

Electrical Review. [*Elec. Rev. N. Y.*] *Weekly.*
41 *Park Row, New York City. Per Year* $3.00.

The Engineer. [*Eng. Cleve.*] *Fortnightly.*
Blackstone Building, Cleveland, Ohio. Per year $2.50.

Engineering Magazine. [*Eng'ing. Mag.*] *Monthly.*
120-122 *Liberty Street, New York City. Per year* $3.00.

Engineering News and American Railroad Journal.
[*Eng'ing News.*] *Weekly.*
220 *Broadway, New York City. Per year* $5.00.

Engineering and Mining Journal. [*Eng. and Min. Jour.*] *Weekly.*
253 *Broadway, New York City. Per year* $5.00.

The Iron Age. [*Iron Age.*] *Weekly.*
232–238 *Williams Street, New York City. Per year* $4.50.

Journal of Electricity. [*Jour. Elec.*] *Monthly.*
421 *Market Street, San Francisco, Cal.*

Journal of the American Chemical Society. [*J. Chem. S.*] *Monthly.*
Easton, Pa. Per year $5.00.

Journal American Society of Naval Engineers. [*A.S.N. Egrs.*] *Quarterly.*
Navy Department, Washington, D. C.

Journal of the Association of Engineering Societies. [*Eng. Soc.*] *Monthly*
257 *South Fourth Street, Philadelphia. Per year* $3.00.

Journal of the Franklin Institute. [*Frank. Inst.*] *Monthly.*
Philadelphia, Pa., Per year $5.00.

Journal of the Military Service Institution. [*Jour. M. S. I.*] *Bi-monthly.*
Governor's Island, New York City. Per year $4.00.

Journal of the U.S. Cavalry Association. [*Jour. U. S. Cavalry*] *Quarterly.*
Fort Leavenworth, Kansas.

Journal of the Western Society of Engineers. [*W. Soc. Eng.*] *Bi-monthly.*
1737 *Monadnock Block, Chicago, Illinois. Per year* $2.00.

Marine Review. [*Mar. Rev.*] *Weekly.*
Cleveland, Ohio. Per year $2.00.

Military Information Division. [*Mil. Information Div.*] *Occasional.*
War Department, Washington, D. C.

Mines and Minerals. *Monthly.*
Scranton, Penn. Per year $2.00.

New South. *Monthly.*
Nashville, Tenn. Per Year $1.00.

Notes on Naval Progress. [*Naval Intelligence.*] *Occasional.*
Navy Department, Washington, D. C.

Pennsylvania Magazine of History and Biography. [*Penn. Mag. of Hist. Quarterly.*
13 *Locust Street, Philadelphia. Per year* $3.00.

The Photographic Times. [*Phot. Times.*] *Weekly.*
60 *and* 62 *E.* 11*th Street, New York City. Per year* $5.00.

Physical Review. [*Phys. Rev.*] *Ten numbers per year.*
Cornell University, Ithaca, New York. Per year $5.00.

Popular Science Monthly. [*Pop. Sc. Mo.*] *Monthly.*
72 *Fifth Avenue, New York City. Per year* $5.00.

Proceedings of the American Philosophical Society.
[*Proceedings of A. Phil. Soc.*]
104 *South Fifth Street, Philadelphia, Pa.*

Proceedings of the U. S. Naval Institute. [*Naval Inst.*] *Quarterly.*
Annapolis, Md. Per year $3.50.

Public Opinion. [*Pub. Opin.*] *Weekly.*
New York City. Per year $2.50.

Review of Reviews. *Monthly.*
13 *Astor Place, New York City. Per year* $2.50.

The Scientific American. [*Scien. Amer.*] *Weekly.*
361 *Broadway, New York City. Per year* $3.00.

Shooting and Fishing. *Weekly.*
293 *Broadway, New York City. Per year* $3.50.

Technology Quarterly. [*Tech. Quart.*] *Quarterly.*
Mass. Inst. of Tech., Boston, Mass. Per year, $3.00.

Transactions American Institute of Electrical Engineers.
[*Inst. Elec. Eng'rs.*] *Monthly.*
26 *Cortlandt Street, New York City. Per year* $5.00.

Transactions American Institute of Mining Engineers.
[*Trans. Inst. Min. Eng'rs.*]
99 *John Str., New York City.*

Transactions of the American Society of Civil Engineers.
[*Trans. A.S. Civil Eng'rs*]
220 *West* 57*th Street, New York City.*

Transactions of the American Society of Mechanical Engineers.
[*Trans. A. S. Mech. Eng'rs.*]
12 *West* 31*st Street, New York City.*

Transactions of the Society of Naval Architects and Marine Engineers.
[*Naval Architects and Marine Eng'rs.*]
12 *West* 31*st Street, New York City.*

Western Electrician. [*West. Elec.*] *Weekly.*
510 *Marquette Building, Chicago, Illinois. Per year* $3.00.

Wilson's Photographic Magazine. [*Phot. Mag.*] *Monthly.*
853 *Broadway, New York City. Per year* $3.00.

ORGANIZATION AND ADMINISTRATION.

Late changes in the French army.—**A. S. M. Zeit.**, September 9.
The Colonial troops.—**Cercle**, September 9, 16.
The Zouaves.—**R. Inf.**, September.
Increase of the French army.—**R. Inf.**, September.
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The French Soudan and its soldiers.—**Heeres-Zeit.**, September 9.
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Military organization.—**Cientifico M.**, September 15.
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The Japanese army.—**Wochenblatt**, September 20.
The English expedition in the event of a South African War.—**Wochenblatt**, September 23.
A study on the organization of the coast artillery.—**Boletin, August.**
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Lord Cromer In Egypt.—**United Serv. Mag.**, October.
The English and Transvaal forces in South Africa.—**Belgique M.**, October 1.
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Field medical service in the advance guard.—**R. Mil. Brazil**, July.
The armies and navies of to-day.—**S. Zeitschrift**, September.
Organization and use of cyclists.—**Monatschr.**, September, October.
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Re-organization of the field artillery (Germany).—**Wochenblatt**, October 28.
The naval budget of the Netherlands for 1899.—**Seewesens**, VII.
The Spanish telegraph service during the campaign in Cuba.—**S. Zeitschrift.**, October.
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The military power of Austro-Hungary.—**Int. Rev.**, October.

Organization of the Telegraph service in France.—**Int. Rev.**, October; **S. Zeitchrift.**, October.

Great Britain and the question of universal service.—**Int. Rev.**, October.

Report of the Adjutant General.—**A. and N. Jour.**, November 4; **A. and N. Reg.**, November 4.

French North Africa and its army.—**Heeres-Zeit.**, October 21, November 11.

Re-organization of the National Guard.—**Jour. M. S. I,**, November.

Supply service in Russian army.—**Jour. M. S. I.**, November.

The Swiss troops.—**Jour. M. S. I.**, November.

The terrain, the men and the arms in war.—**A. Belge**, July-August.

The English standing army.—**Monatschr.**, October.

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Ammunition columns for mountain or irregular warfare.—**Proc. R. A. I.**, August.

Strength and composition of the English forces to oppose the Boers.—**Wochenblatt**, October 28, November 4, 8.

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Organization of the French artillery.—**S. Zeitschr.**, October.

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The service of security of cavalry.—**R. Cav.**, September.

Reconnoissance during battle.—**Wochenblatt**, September 9.

Tactical problem (Berlin War Academy).—**Cercle**, September 9, 14.

History of the French infantry.—**R. Inf.**, September, October.

Artillery scouts.—**Cercle**, September 2; **Belgique M.**, September 3.

The U. S. Instructions to blockading veasels and cruisers.—**Mar. Rundschau**, August-September.

Tactical and strategical considerations of the Greco-Turkish war of 1897.—**Heeres-Zeit.**. September 2.

The defense of coasts.—**Heeres-Zeit.**, September 2; **R. G. de Marina**, September-October; **M. de Art.**, June, July.

The use of cavalry.—**Heeres-Zeit.**, September 2.

The tactics of field medical service.—**Heeres-Zeit.**, September 9, 16.

Distribution of the fire of artillery.—**R. Artillerie**, September, October.

Military espionage.—**Porvenir**, July 24, September 5.

Course of applied tactics.—**Porvenir**, September 25.

Tactical problem.—**Cercle**, September 30, November 4.

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The effect of the British field artillery at Omdurman.—**S. Zeitschrift**, September.

A French view of the American cavalry in the war of secession, 1861-65.—**R. Cav.**, September.

The psychological elements in attack and defense.—**Wochenblatt**, 7.

The battles of the French Republic in 1870-71.—**Wochenblatt**, 7.

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The tactics of field artillery.—**Int. Rev.**, November. Supple. 8.

Supply of ammunition in the field.—**R. Mil. Brazil**, August.

The tactics of the Boers.—**Eng.**, October 13; **Belgique M.**, October 8.

The war at sea and its lessons.—**R. Maritime**, August.

Exterior means of action of warships.—**R. Maritime**, August.

The probable loss in guns in action.—**R. Maritime**, August.

Napoleon I on naval wars.—**Heeres-Zeit.**, October 11.

Formations against cavalry.—**R. Inf,**, October.

Battle tactics.—**Marine F.**, October.

Introduction to the study of naval tactics.—**Circulo Naval**, July.

The service of exploration.—**Circulo Naval**, July, August.

Hill-fighting.—**Jour. R. U. S. I.**, October.

The defence of the Indian frontier.—**A. and N. Gaz.**, October 21.

Permanent fortification and the attack and defense of fortifications (Leithner).—**Mitth. Art. u. G.**, 10.

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